PRACTICAL ENGINEER

Trade-mark, Reg. U. S. Pat. Off.

SEMI-MONTHLY

VOL. XX. CHICAGO, MAY 15, 1916 No. 10

Power for Packing Pork

PLANT FURNISHES POWER, REFRIGERATION, HEAT, LIGHT AND WATER NECESSARY FOR THE PREPARATION OF MEATS

WHEN YOU EAT YOUR breakfast of ham and eggs, or your luncheon of frankfurter sandwiches, doughnuts cooked in real leaf lard, and coffee, or your evening meal of roast pork and apple sauce, and compliment your good wife upon the supreme quality of the meals she cooks, little do you think what part engines just like yours, ice machines of your favorite type, and boilers that eat B.t.u.'s all day long, have had in bringing to your table the most delicious as well as nutritious of meats.

W. C. Routh & Co. are packers of pork at Logansport, Ind.; their special product is Quail Brand hams and bacon. Power used in this packing house is by no means a small item, and refrigeration plays an important part in the preparation of the meat for market.

STEAM GENERATING EQUIPMENT

IN THE boiler room, 2 Stirling boilers have recently been installed. These are of the standard type with 3-pass baffling, rated at 252 hp. each, equipped with Martin shaking grates with 50 sq. ft. of grate surface to each boiler. On each boiler are 2 4-in. Crane pop safety

FIG. 4. VIEW OF ENGINE ROOM SHOWING 40-TON ICE MACHINE WITH AIR COMPRESSOR IN BACKGROUND

valves and in the 6-in. leads to the header are Crane automatic non-return stop valves. The 10-in. header runs through the old boiler room to the engine room, all steam piping being thoroughly insulated with magnesia covering. The steam pressure carried is 100 lb. with the safety valves set at 101 and 102 lb.

Indiana run-of-mine coal is burned and the alternate wing system of firing is employed, keeping the average depth of the fuel bed at 4 in. and firing lightly, only 2 or 3 small shovelfuls beings thrown on at 2 to 3 min. intervals. The value of this method of firing is shown by the record from a pressure gage reproduced here, Fig. 2. Draft is regulated by hand-operated dampers and during a test made to determine best operating con-

FIG. 1. INSTALLATION OF STIRLING BOILERS

ditions, the draft at the breeching was ⅜ in. of water, in the middle bank of tubes ¼ in., and over the fire 1/16 in. The chimney is of reinforced concrete, 129 ft. high and 5 ft. diameter.

Fires are cleaned every 6 hr., soot is blown from the tubes once a day and the boilers are cleaned internally once each month. Perolin boiler metal treatment is used and has given good results, though previous methods of water treatment had been unsatisfactory. The Perolin is fed into the front and rear drums twice a day by means of 2 small pumps.

In the old boiler room are 2 horizontal return tubular boilers, 72 in. by 16 ft., rated at 150 hp. each. These are used now only as auxiliaries.

Engine Room Equipment

In the engine room the principal machinery consists of 2 ice machines, one power engine and an air compressor. Taking them in order, the large ice machine, rated for 100 tons a day, is a horizontal Triumph machine 16 by 30 in., direct connected to a Hamilton-Corliss steam engine, 18 by 42 in., and runs at 64 r.p.m. The head pressure carried is 170 lb., and the suction, 15 lb.

Power for driving the machinery of the plant is supplied by a Nagle-Corliss engine, 14 by 36 in., rated at 90 hp., which runs at 80 r.p.m. and has a 13-ft., 5-ton flywheel from which is belted the line shaft. Most of the machinery of the plant is run from the line shaft by belts, of which there are in all about 2000 ft. in the plant. A 25-kw. General Electric d.c. generator is also run by belt from the line shaft and supplies current at 110 v. for lights and motors used about the plant.

The 40-ton ice machine is also a horizontal type Triumph with a compressor cylinder 12 by 20 in., and is direct connected to a Nagle-Corliss engine, 14 by 36 in., at 75 r.p.m.

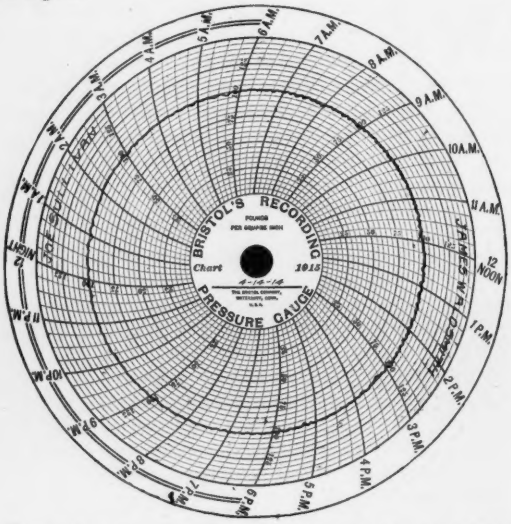


FIG. 2. RECORD SHOWING EXCELLENT WORK OF FIREMEN

To furnish compressed air, a 20-ton Frick ice machine is used, of the angle type, the 2 single-acting compressor cylinders being vertical while the steam end is horizontal. The machine runs at 60 r.p.m. as an average speed and compresses air to 100 lb. pressure.

Water Supply

Water for the packing plant is an important item and at this plant there are 3 sources—a river, a spring and a deep well. Water from the river is pumped by an 8 by 8 by 10-in. Burnham simplex pump to an elevated tank and used for house service and washing inedible products. Spring water runs into a reservoir from which it is pumped as needed for washing, brine-making, etc., by a Dean Bros. 7 by 4½ by 10-in. duplex pump.

Well water is used first for condensing the ammonia, then goes to the plant for washing purposes. This water also goes to the heaters and is used for feeding the boilers and also for scalding. The well is 6 in. in diameter and

109 ft. deep, and is operated with compressed air by an Indiana air-lift pump, working under a head of 23 ft. and having a submergence of 65 per cent.

Use is made practically the year around of all the exhaust steam from the engines and pumps; in order to supply the necessary amount of heat for the buildings, the vacuum evaporator, hair-drying, cooking and rendering processes, as well as water heating, a back pressure of 3½ lb. is carried on the engines.

There are 2 Stilwell open type heaters in the plant, one of 200 hp. capacity heats water for scrubbing purposes and is located in the engine room. The other has a rating of 500 hp. and heats the boiler feed water; it is located in the boiler room. The feed pump is a 7 by 4½ by 10-in. Dean Bros. duplex, which is hand regulated. The brine pump is located in the engine room and is a McGowan duplex 6 by 6 by 10 in.

The ducts through which the air rises from the chill rooms to the cooling coils are provided with dampers by means of which steam from the freshly killed meat is conducted outside the building; as soon, however, as the steaming stops the damper is turned and the air circulates through the coils and chill rooms.

Beneath the chill rooms is a curing cellar which is cooled by the same system of indirect air circulation. Here the barrels of pickled meats are kept until in proper condition for marketing.

For storage of cured meats a sharp freezing room is provided where the temperature is maintained at 20 deg. F. (—7 deg. C.); here direct expansion coils are used.

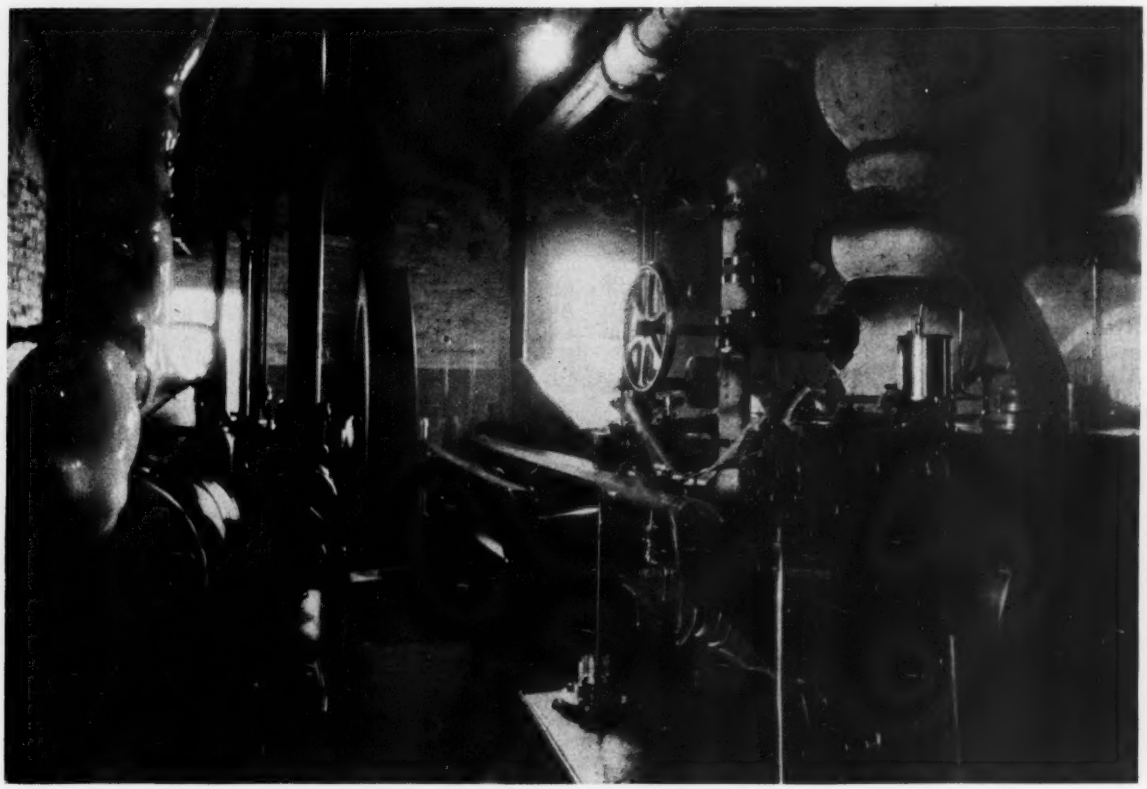


FIG. 3. MAIN ICE MACHINE IN OPERATION

Uses for Refrigeration

A visit to the refrigerating rooms was interesting as an example of diversity in refrigeration. Four pork chill rooms are cooled by an indirect system; in a compartment above these rooms are located direct expansion coils, over which brine flows by gravity exposed to the atmosphere. Air circulates around these pipes and is driven down to the chill rooms by a fan, whose capacity is 37,500 cu. ft. a min. and which is driven by a 7½-hp. motor. The total capacity of the chill rooms is 400 hogs, cooled down to 32 deg. F. (0 deg. C.) in 24 hr.

In the dry salt curing cellar, the brine spray system of cooling is employed. By this system the brine is sprayed from pipes to troughs beneath, all of which are suspended from the ceiling, requiring more head room than the pipe system, but the troughs being open, give a ventilated and purified condition to the atmosphere in the room. In some cases, however, where head room is not available, the closed brine coil system is employed.

In the beef chill room the open spray brine system is employed and serves to keep the atmosphere of the room in good condition.

A combination of open brine spray and closed pipe systems is used in the shipping room, lard rooms and the sausage chill room; direct ammonia expansion cooling coils are used in the fresh meat room, which is main-

tained at a temperature of 22 deg. F. (—5.5 deg. C.); direct expansion and brine pipe coils are used in the storage room for sausage and hams, the temperature here being 34 deg. F. (1.11 deg. C.).

To determine the friction load of the plant, the engine was recently run on Sunday and it was found that with all machinery running idle, the indicated load on the engine was 26.18 hp. From this and the steam consumption of the engine as shown by test, it was calculated that the cost of coal per day of 10 hr. for friction is $1.30 when the average evaporation is 7 lb. water per pound of coal.

Experiences with Corliss Engines

ANNOYING TROUBLES AND THEIR REMEDIES. BY H. A. JAHNKE

CORLISS steam engine valves and their stems give much trouble at times and some of the troubles the writer has had with them and how these were remedied, are related here for the benefit of others.

The exhaust valve ports of a Corliss engine were rebored and new valves were fitted. When the engine was in service again there was a groaning noise in the crank end valve which could not be stopped by giving more oil. The valve was pulled out, but there was plenty of oil on the working surface and no sign of cutting anywhere. The valve was covered with graphite and cylinder oil, then replaced. After the engine was started the noise was still there. As there was not time to shut down the engine again, and I was sure there was no cutting going on at the valve, I waited until the next Sunday, then pulled out the valve and stem, when the cause of

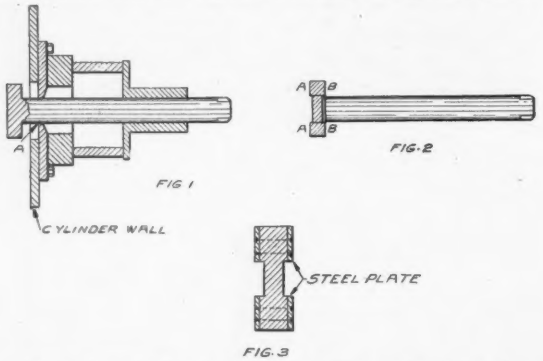


FIG. 1. VALVE BONNET SHOWING LOCATION OF WEARING POINT

FIG. 2. TEE RIVETED TO MAKE TIGHT FIT

FIG. 3. END OF VALVE STEM TEE WITH STEEL PLATES RIVETED ON

the trouble was found. The valve stem was bearing quite hard at the bottom of the hole in the front bonnet, as shown in Fig. 1 at A. As no oil could get there, it made the groaning noise. The trouble was quickly cured by filing a little off at the stem at this point. I believe the trouble was caused by the valve and stem not being in line with the center of hole in the bonnet.

PACKING CAUSE OF NOISE

WHERE soft packing is used on Corliss valve stems, the oil hole in the packing gland is liable to get clogged up from the gummy matter of the packing when the stem gets dry in the gland, and at times causes a squeaky noise. A case of this kind occurred at one time where a squeaky noise was heard at the head end steam valve; more oil did not seem to help any. In looking at the packing gland one day, I noticed that this moved a little at each opening and closing of the valve. Then I knew where the trouble lay; it was in the packing gland.

That night, the valve and stem were removed, when it was found that the gland and stem were very dry, due to the fact that the oil hole was clogged up. Cleaning the oil hole and oiling the stem with graphite and cylinder oil cured this trouble.

Trouble of this kind may not occur where the packing is renewed quite often. Should the oil hole in the gland get clogged, the gland and stem will receive more or less lubricant from the packing; but where the packing remains in the stuffing-box until it gets hard, having no lubricant in it any more and as the stem may leak a little, it will cause rust at the gland and stem whenever the engine is idle. When the engine is started again, there is a squeaky noise. The proper thing to do is to keep the oil hole in the gland always open and use cylinder oil for oiling this bearing in place of engine oil, as is mostly done.

VALVE STEM KEY CAUSED NOISE

IN ANOTHER instance, the exhaust valve ports were rebored and new valve fitted on a Corliss engine. When the engine was in service, all worked well until a few days later, when a groaning noise was noticed in the crank end valve. More oil did not remedy the trouble. Then the valve was taken out, but showed no sign of being dry or cutting. The valve was replaced until there was time to take it out again, also the stem, to examine both closely. In placing the eye bolts in the end of the valve later on, then trying to find if there was loose motion in the valve connection, I found there was very little. The valve gear was hooked up solid and the valve was moved forward and back by means of the eye bolts by the helper, while I examined all connections to the valve, when I found the key in the valve stem and bell crank had lost motion sidewise, also the key was not driven in tight, which allowed the bell crank to move a little on the stem at each opening and closing of the valve; I was sure that this was the cause of the noise. A wider key was fitted and driven in tight and there was no more noise.

VALVE STEM TEE HAD TOO MUCH PLAY

WHERE there is much play at the tee of a valve stem and slot in valve, it will cause noise. This can be cured at times by riveting the tee on the stem at the points A B, as shown in Fig. 2, so as to have a tighter fit in the valve slot. I had a case of this kind some time ago. In examining the valve stem tee and slot in the valve, I found excessive wear. As riveting of the tee would not remedy

this, a repair was made in the following way. The slot in the valve and tee on the valve stem were filed to an even surface, then soft steel plates were riveted to both sides of the tee to fill up the space in the valve slot as shown in Fig. 3.

Valve Stem Bearing Worn in Bonnet

Where the valve stem bearing in the front bonnet is worn much, to allow the stem to move sidewise it will cause trouble at times. In the first place, it will cause the tee on the valve stem and slot in the valve to wear much quicker, due to the side motion of the stem at each opening and closing of the valve, besides the packing does not last long under these conditions. This should be corrected at the first opportunity by either bushing the bearing in the bonnet or replacing it by a new bonnet.

The above calls to mind the experience I had some time ago with a new steel valve stem and a front bonnet which was worn a little. A new steel stem was fitted to an old exhaust valve. After the engine was in service for a few days, there appeared a squeaky noise which seemed as if it was in the valve having the new stem. Feeding more oil did not help any. Then the valve was pulled out, as I thought that it was binding somewhere, due to the valve stem tee having a snug fit in the slot of the valve, which perhaps did not allow the valve to seat in its former position. I found, however, in examining the stem and valve that the trouble lay in the stem and bonnet bearing, as there were some high points in the bonnet bearing due to wear when the stem did not get sufficient lubrication. A little scraping in the bonnet and filing of the valve stem, then feeding graphite and cylinder oil to the bearing for a few days, cured this trouble.

Running in New Valves

In some instances, much trouble is had with running in new Corliss valves. This will occur in new engines as well as where the valves are renewed in old engines. At times, it is necessary to change cylinder oil several times before the right oil is found. It is best when running in new valves to feed much more oil to the cylinder for 5 or 6 weeks than is usually necessary, then cut down on the oil gradually. This is better than to be saving at the beginning and have scored valves later on, as it does not take long to score new valves by insufficient lubrication.

At times, a new valve will run nicely for a few weeks, then suddenly make a groaning noise which no amount of oil will stop. Sometimes this is caused by sharp edges on the working edge of the valve, which scrape the oil off the bearing surface; this can be overcome by filing off the sharp edges a little.

I have had trouble with new valves groaning where no oil or filing of edges would stop the noise, but overcame the trouble by taking out the valves, mornings and noons, then covering them with graphite and cylinder oil for a few weeks, or until there was no noise when feeding oil only to the cylinder.

Efficient Operation of Boiler Rooms

Large Railway Plant Has Double Ended Furnace, Employs Regular Test Gang, Boiler Water Tested Daily for Sulphates but Boilers Never Blown Down

In this article attention is called to some of the operating features of a plant furnishing power for electric passenger trains requiring 80,000 kw. at peak load periods. The load upon the plant, however, is quite regular, so that a schedule is made out, giving the firemen instructions as to the number of boilers to have in operation at various periods of the day, as well as the number to keep banked.

In the boiler room are 60, 600-hp. B. & W. boilers, arranged in 10 batteries of 6 each, 2 boilers to a setting. Twenty-four of these boilers are equipped with 7-retort Taylor stokers, 18 with front and back Roney stokers with a projected area of 200 sq. ft., and the remaining 18 boilers are equipped with single Roney stokers, each having a projected area of 112 sq. ft. Eight of the boilers are equipped with B. & W. and 4 with Foster superheaters, all located above the first pass of the boiler, and give 100 deg. F. (55.5 deg. C.) superheat to the steam, which is carried at 215 lb. pressure. The baffling of the boilers is such as to lead the gases over the tubes 3 times, which is the standard of the B. & W. construction in all boilers except the 18 equipped with front and back Roney stokers. The accompanying sketch shows the arrangement of baffles employed in these 18 boilers.

The Roney stokers are provided with specially designed grate bars, which it is reported give larger air space and longer life to the grate bars as radiation surface is increased by the use of fingers.

Boiler Details

Water columns are placed on 2 of the 3 drums of each boiler with connections through the front head and, to insure correct indication of water level, which is carried at about 2 gages, they are blown down 3 times a day. The feed line enters the front head of each drum and passes through the steam baffles, discharging the water below the level in the boiler. There are 2 blowoff connections to each mud drum, but these are never used except to empty the boiler before cleaning. All boilers are provided with the standard number and size of handholes and manholes, and in addition 5, 6 by 8-in. handholes in the mud drum.

Safety valves are placed on cross headers between the drums of the boilers and set to blow at 220 lb., each valve discharging through a muffler. There are 4 of these valves, each 4-in. in diameter, on 42 of the boilers, but on the 18 which are equipped with the double end furnaces, there are 4, 4-in. valves, and 2, 4½-in. in diameter. These valves are all tested every 2 weeks to see that the disks do not stick to the seats.

Fuel and Firing Methods

Pennsylvania bituminous coal with a heat value of about 14,500 B.t.u. is used in this plant. On the Roney stokers the bed of coals is carried at an average of about 11 in., while on the Taylor stokers it is about 15 in. This depth, however, depends largely on the load which

is being carried. The average evaporation per pound of coal varies from 10.8 to 11.2 lb. of water.

In boilers equipped with 2 Roney stokers, the draft is carried at 0.35 in. of water in the third pass, and in the single Roney arrangement 0.25 in. There is no induced fan, so that the boilers equipped with Roney stokers depend entirely upon natural draft for their operation. For furnishing air to the Taylor stokers a pressure of 3½ in. is carried under the tuyeres, although this varies somewhat as the load changes.

Coal is delivered to the power plant in boats from which it passes through a crusher, and by means of a series of 10 Robbins belt conveyors is delivered to the bunkers over the entire boiler room. There is storage space here for about 14,000 tons, and from these bunkers 2 chutes conduct the coal to each stoker. The coal is weighed as it leaves the boat, and the amount left in the bunker at the end of the month is estimated, and at times when boilers are being tested the coal delivered to the stokers is weighed as it is used.

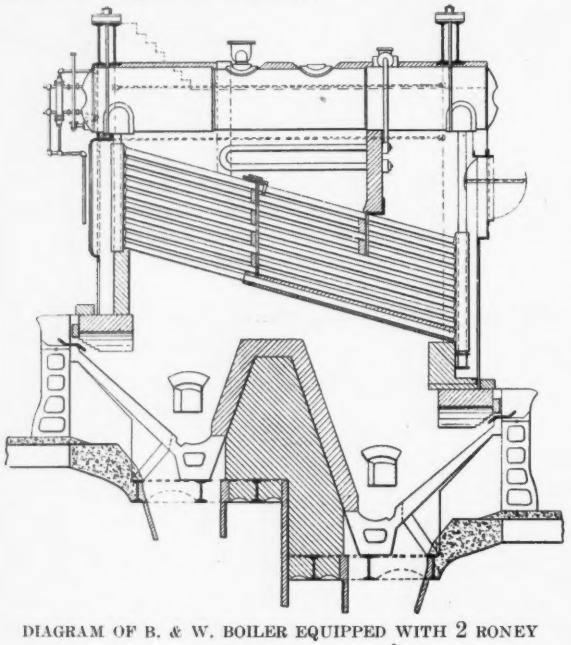


DIAGRAM OF B. & W. BOILER EQUIPPED WITH 2 RONEY STOKERS

An exact account of the water fed to the boilers is not kept, but a city water meter is read every 24 hr., and from this a close approximation can be made of the amount fed to the boilers. Some of the engines are equipped with surface condensers, and the condensate from these is returned to the heater. There are, however, a number of generating units which are equipped with barometric condensers so that no returns from these go back to feed the boilers.

While no steam meters are provided for the boilers, there is a test gang employed which is kept busy testing various parts of the plant, and a general idea of the operating conditions is thus obtained for comparison.

In this plant the following temperature records are kept: Outside air; atmosphere in the boiler room; temperature of city water; condensate returning to the heater which averages 96 deg.; discharge from the heater which varies from 160 to 170 deg.; water to the boilers from the economizers, which averages about 200 to 205 deg. A record of the flue gas temperature is not kept; neither is the percentage of CO_2 recorded, but these are determined at times when tests are made, when the flue gas contains from 14 to 15 per cent of CO_2.

Maintaining Clean Boilers

Water entering the heater is treated with Solvay process soda, and this treatment is supplemented by feeding a compound into the feed line of the boilers when it is found that the impurities in the boiler water of the individual boiler are higher than they should be. In order to determine whether the proper amount of compound is being fed to the boiler, a sample of the water is drawn from the water columns every day and tested for sulphate. The engineer reports that after continued and repeated experiments he has found that no scale will be formed upon the tubes below a certain percentage of saturation, and when the water in the boiler has reached to nearly the point where the scale-forming material is precipitated the boiler is taken out of the line. By this means a program of operation has been worked out so that boilers equipped with the single Roney stokers are cleaned every 60 days, those with 2 Roney stokers every 30 days, and those with Taylor stokers every 40 days.

When the boilers are taken off the line the 2 bottom rows of tubes are turbined, although it is reported that no hard scale is formed when the above program is carried out. Before the boilers are put into service again they are tested to 338 lb. hydrostatic pressure.

Boilers are given a general cleaning every 8 to 9 months, at which time all parts of the boiler setting and furnace are given a thorough overhauling. Soot is blown from the water tubes by means of the steam pipe with a perforated nozzle. This is done every other day. All boilers which are equipped with the single Roney stoker and Taylor stoker are provided with a soot pit back of the bridge wall.

This discharges through a pipe into industrial cars which run on a track beneath the boiler setting. Those boilers equipped with 2 Roney stokers have a horizontal baffle over the back furnace upon which considerable soot may collect. This is scraped into a pipe which leads to the ashpit beneath the furnace.

Draft is regulated by means of hand dampers in the boiler breechings of which there are 2 to each boiler. Forced draft is, of course, used with the Taylor stokers, and all Roney stokers are provided with 2 steam jets to each stoker, which are used when the boilers are forced beyond the capacity of the natural draft.

Ashes are removed from the hoppers twice each day, except in the case of the back furnaces where the hoppers are necessarily smaller, and are emptied twice during the day time and once at night. The ashes are carried by industrial cars to a bucket conveyor which delivers them to an ash storage, or to a scow on the river.

Boiler settings are watched carefully for cracks, and when discovered in the furnace walls or baffles, they are stopped up with fire clay and ganister; cement is used for stopping cracks in the common brick.

The average rate of fuel consumption per square foot of grate surface per hour on the Roney stokers is 25.3 lb., while that with the Taylor stokers is 42 lb.

Prevention of Corrosion in Pipe

Comparisons of Factors Involved with Various Kinds of Pipe and Systems

INTERESTING results on this subject were recently presented by F. N. Speller of Pittsburgh, Pa., at a meeting of the American Society of Heating and Ventilating Engineers.

Casual observation will show marked differences in the degree of corrosion of pipe in service. For instance, hot-water heating systems and sprinkler systems show virtually no deterioration in service after 25 yr., while low-pressure steam returns sometimes give trouble after 15 yr. service or less. Galvanized pipe in hot-water supply systems, where the water is heated under pressure, lasts from about 5 yr. upwards, depending on the temperature and quality of the water and volume of flow. The last named condition is so severe on iron and steel pipe that brass pipe must sometimes be used, at a cost approximately 10 times that of galvanized pipe.

Some years ago, when steel pipe was comparatively unknown and not fully developed, it was natural to question this material; but comparisons of modern wrought iron and steel pipe in the same lines of service have shown that where corrosion is found, one material suffers, on the average, as much as the other.

The inside of the pipe is subject to peculiar conditions not to be compared with the external corrosion. It is evident that the water alone is not responsible for the results observed, but rather something brought in with

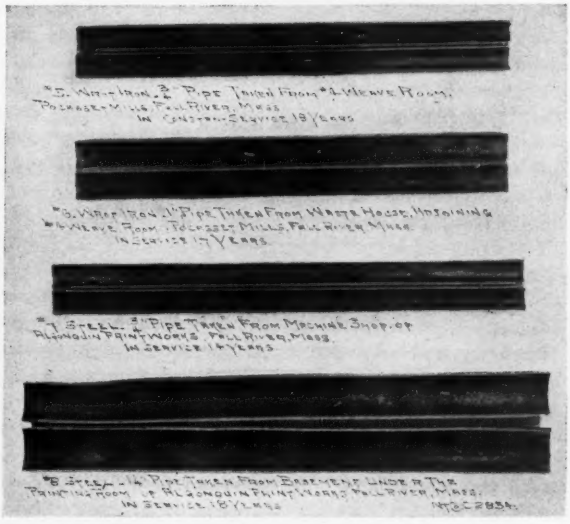

"5. WROUGHT IRON 2" PIPE TAKEN FROM "4 MEAVE ROOM, POCASSET MILLS, FALL RIVER, MASS. IN CONTINUOUS SERVICE 18 YEARS
"3. WROUGHT IRON 1" PIPE TAKEN FROM WASTE HOUSE, CONTAINING "4 MEAVE ROOM, POCASSET MILLS, FALL RIVER, MASS. IN SERVICE 17 YEARS.
"1. STEEL 2" PIPE TAKEN FROM MACHINE SHOP OF PLIMPTON PRINTWORKS, FALL RIVER, MASS. IN SERVICE 14 YEARS
"6. STEEL 1 1/4" PIPE TAKEN FROM BRAKE-EYE LINDE IN THE PRINTING ROOM OF PLIMPTON PRINTWORKS, FALL RIVER, MASS. IN SERVICE 16 1/2 YRS.

FIG. 1. SECTIONS OF 4 SAMPLES TAKEN FROM SPRINKLER SYSTEM

the water. Hot-water heating lines have started to rust and then the action has apparently stopped, while in hot-water supply lines the action is so continuous and rapid that, if the pipe does not fail by leaking, it may be plugged tight with the reddish hydroxide of iron. The only way to account for this accumulation of oxide of iron is from the oxygen in solution in the cold feed water, amounting to 9 to 17 cu. in. per cu. ft., according to the temperature and quality of the water. This very small percentage of oxygen is apparently the measure of the destructive power of the water and accounts for the fact that a limited volume of water has no serious action on iron, whereas, when this volume of water is renewed continually, especially when heated, the results are liable to be disastrous.

Corrosion of low-pressure steam lines will be found to depend principally upon the amount of oxygen which finds access to the system. The return lines naturally suffer the most and are usually the first to show failure.

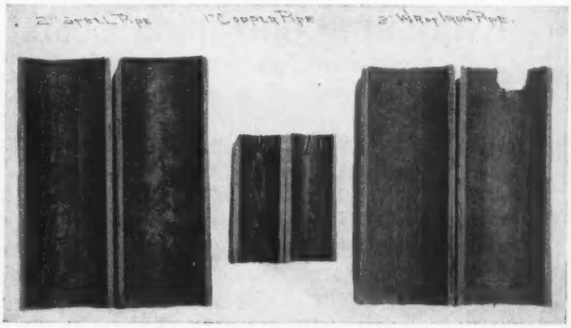


FIG. 2. PHOTOGRAPH OF 2-IN. WROUGHT IRON AND STEEL PIPE USED IN OPEN HEATING

Condensed water, when freed from oxygen in solution, is harmless, and will not even tarnish bright iron after months of exposure; but this water, on account of its great purity, has greater capacity for solution of oxygen than the average natural water, and is, therefore, apt to be corrosive when aerated. This may be prevented in large measure by using an open feed water heater and keeping the water over 185 deg. F.

FIG. 3. TABLE SHOWING RESULTS OBTAINED FROM SERVICE TESTS

No.	Date	Locality	Length of Time Pipe Lines Were Installed	Character of Service	Authority	Number of Cases on Record	Average of Deepest Pits		References for Details and Remarks
							Wrought Iron	Steel	
1	1910	New York City bath-houses.	3 yrs. and over	Hot water supply service.	Prof. Ira H. Woolson, Columbia University.	89 samples secured, of which 17 are wrought iron and the remainder steel.	EQUAL 100%	100%	Eng. News, Dec. 3, 1910, p. 630; N. T. C. Bulletin No. 2. This was a test of iron and steel pipe in actual service continued to destruction.
2	1910	Frick Coke Co. power plants.	6 mos. to 7½-8 yrs., varying with the comparisons secured.	Boiler feed water lines.	Research Laboratory National Tube Co.	21 lots comprising 53 samples, of which 26 are iron and 26 steel.	.112" 100%	.108" 96%*	Eng. Review, April, 1911; N. T. C. Bulletin No 3; Amer. Soc. Heating & Ventilating Engrs., 1911. Pipe samples secured from lines in actual use. In 22 cases of adjacent iron and steel pipes in same lines, 12 comparisons favor steel and 9 iron.
3	1911	Cresson (Pa.) coal fields.	6 mos. to 10 yrs., varying with the comparisons secured.	Hot and cold water boiler feed lines; pump discharge lines.	Research Laboratory National Tube Co.	9 comparisons of iron and steel found together.	.100" 100%	.085" 85%*	Pipe samples secured from lines in actual use. In 9 cases of adjacent iron and steel pipes found in same lines, 4 comparisons favor steel and 2 iron; in 3 cases the steel and iron are equally corroded.
4	1911	Allegheny General Hospital.	Between 7 and 8 years.	Hot water supply service.	Research Laboratory National Tube Co.	69 samples from hot water lines, 42 wrought iron and 27 steel.	.100" 100%	.105" 100%*	Conditions those of actual service, and pipe was tested to destruction. In 13 cases of adjacent iron and steel pipes found in same lines, 7 cases favor steel and 6 iron.
5	1911	New England Investigation.	2 yrs. to 17 yrs., varying with the comparisons secured. Average 9 yrs.	Hot and cold water, live and exhaust steam, brine, boiler blow off lines, etc.	Dr. W. H. Walker, Director Research Laboratory of Applied Chemistry, Massachusetts Institute of Technology.	54 comparisons of iron found together, in hot water and steam lines.	.060" 100%	.083"* 91%*	Eng. News, Dec. 21, 1911; Jour. of New England Water Wks. Assn. Jan., 1912. Actual service conditions. In 54 cases of adjacent iron and steel pipes found in same line, 20 favor steel and 16 iron, 9 show no difference in corrosion and 7 no corrosion at all.
6	1913	New York City Hotel Investigation.	6 to 10 years.	Hot water supply and steam return lines.	Dr. Wm. Campbell, Columbia University, co-operating with Research Laboratory N. T. Co.	From 60 samples 9 comparisons of iron and steel were found	.016" 11%%	.057" 70.5%	Conditions those of actual service, pipe used to destruction. The iron samples failed in 20 spots; the steel failed in 2 places, due to pitting.

NOTE—Depth of pitting in wrought iron samples considered as 100% in all cases. *Calculated from the deepest pit in each sample.

In some cases the surface of the pipe may be protected with a film of oil deposited from the steam. In one instance it was found that mineral lubricating oil, when dropped into a pipe carrying steam under pressure, at the rate of two drops a minute, was found condensed in a uniform film in the pipe about 160 ft. from the lubricator. The de-aeration of water through plants designed for that purpose should, at moderate expense, increase the life of some piping systems 4 or 5 times.

Estimating on Piping Costs

IN reply to a question as to a reasonable basis for estimating the cost of a piping installation, an engineer and contractor of wide experience has compiled the following figures, based on contracts executed in the middle west:

A study of the relative cost of labor and material for high-pressure piping installations taken from the cost records of a number of recent completed contracts shows a range of percentage which can be explained in various ways, and is affected by the accessibility and rapidity of installation of materials as well as by the familiarity by the fitters with the particular class of work.

In one particular case, a contract was completed which in general was the same as 50 similar contracts within the past 7 yr., where the relative percentage between the cost of material and labor showed a 10 per cent ratio; the earlier contracts of this general type of work indicated this percentage to be between 35 and 40 per cent. This was, of course, due to the familiarity of the fitters with the work.

The range in percentage showed the following:

Material $200 and under in cost showed a 40 per cent labor cost.

Material $200 to $500 in cost showed an average 40 per cent labor cost.

Material $500 to $1000 in cost showed an average 45 per cent labor cost.

Material $1000 to $2000 in cost showed an average 25 per cent labor cost.

Material $2000 to $5000 in cost showed an average 20 to 30 per cent labor cost.

Material $5000 to $10,000 in cost showed an average 40 per cent labor cost.

Material $10,000 to $25,000 in cost showed an average 20 to 35 per cent labor cost.

Of course, the safest practice is to make each proposal bear its correct estimate of labor expense regardless of the percentages, and these figures are given merely as averages from a number of contracts, 4 to 6 under each heading, extending over the past 4 yr. The percentages given are for regular material for 175 lb. pressure, and are further affected by higher grade of materials if needed to withstand greater pressures, superheat, peculiar conditions of operation, etc., all of which would raise the cost of material, with cost of labor about the same as for regular installations.

AN ALLOY of zirconium and iron has been proposed for lamp filaments, as it is tough, malleable and ductile. Its radiation is highly selective, providing high luminosity at low temperature.—Electrical Review and Western Electrician.

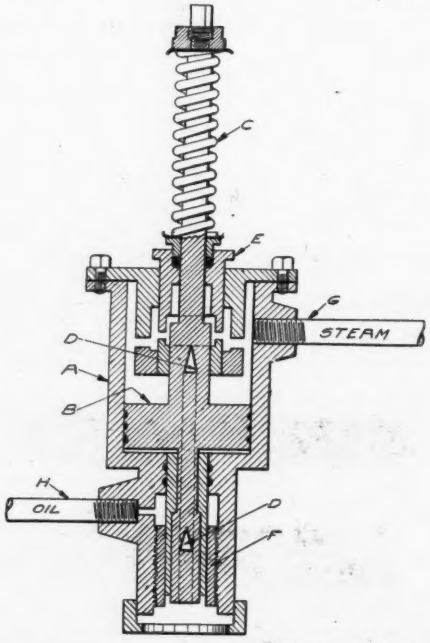
A Novel Fuel Oil Regulator

BY N. W. DUELL

IN THE accompanying illustration is shown a new fuel oil regulator invented by J. C. Auckland and J. L. Atkins, of Washington, and known as the A and A Regulator.

The essential parts of this regulator consist of a cylindrically shaped body A, spring C, and combined piston rods, B, the latter provided with triangularly shaped ports in communication with the burner proper by a passage through the piston rod.

Steam and oil connections are as shown. When little or no steam pressure exists piston B, due to the tension of spring C, will be in its upper position with steam and oil ports D wide open, and in direct communication with the steam and oil supply. As the steam pressure rises, piston B will descend partially, closing steam and oil ports D and thereby throttling the supply of fuel.



SECTIONAL VIEW OF A AND A FUEL OIL REGULATOR

The proper mixture of oil and steam is obtained by adjustment of sleeves E and F.

FROM HELSINGBORG in Sweden, electric current is now being delivered to Elsinore, Denmark, some 10 mi. distant via submarine cable. The initial transmission is 500 hp., which is soon to be increased to 5000 hp. The power is derived from waterfalls.

AT THE University of Illinois Railway Testing Laboratory a recent test on a locomotive for a short time showed 224.5 pounds of coal were burned per square foot of grate per hour. The maximum quantity of cinders ejected into the front end and from the stack was 27.4 per cent of the dry coal fired. The draft during the test was equivalent to 12.8 inches of water in front of the diaphragms.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

Oil Leakage

INJURIOUS EFFECTS OF LUBRICATING OIL ON COMMUTATORS AND ARMATURE WINDINGS; METHODS OF PREVENTING OIL CREEPING. BY GORDON FOX

OIL is an excellent thing in its place. Out of place, it is equally undesirable. This statement is more or less true in general, but particularly so in the case of electric motors and generators. Some electrical apparatus is designed for immersion under oil. The insulation is then selected with this usage in mind. Moreover, the oil used is of special grade and the receptacles are always totally enclosed and protected from dirt. Lubricating oil, on the contrary, has a decidedly detrimental effect upon ordinary insulation. Rubber insulations are dissolved slowly by oil and every electrical worker is familiar with the greasy, gummy substance which results from such a combination. Nearly all varnished windings soak up oil, the impregnated coils alone being impervious.

The vulnerable points of motors and generators commonly suffering from oil leakage are the commutator, brush stud insulation and connecting leads, lower field coil or coils or, on alternating-current machines, the primary windings. The order of mention represents the relative frequency of trouble from this cause. The commutator is much the most easily injured part. Here the difficulty arises through disintegration of the mica. The binder used for bonding together the multitude of small bits of mica is subject to slow dissolution from oil. If oil in sufficient quantity gathers on the mica end ring of the commutator, the insulation slowly deteriorates and finally a ground occurs, usually at the inner corner of the mica ring, a point at which the oil can accumulate. Another effect of an oil soaked end ring is loosening of the mica until it becomes somewhat mushy. It then fails to retain the commutator segments firmly; as a result, the commutator may become eccentric or high bars or flats may appear.

Probably more common than end ring failure is carbonization of the mica segments themselves. Here the action of the oil is usually a little different. When oil soaks into the mica at the surface of a segment, it is likely to start collection of carbon or copper dust, in minute quantities to be sure, but to a sufficient extent to cause leakage of current across the insulating barrier from commutator bar to commutator bar. If this leakage is of considerable magnitude, enough current may flow to cause incandescence of the conducting particles retained in the mica. This action is commonly called "ring fire," since the rotation of the armature causes the bright spots to appear as fine rings of reddish fire encircling the commutator circumference, wholly or in part.

The effect of these incandescent particles is carbonization of the oil immediately adjacent to them. This enhances the leakage and aggravates conditions. Shortly a black spot forms in the mica segment and this may assume considerable depth if not promptly remedied. If the defect is small, the blackened mica may be scraped out with a broken hack saw blade and the void filled with a paste composed of powdered mica, plaster of paris and shellac. This is baked gently with a torch until hard and then smoothed off. If a mica segment is badly pitted, it is necessary to remove the end ring, disassemble a small sector of the commutator and remove the defective segment. Using this as a pattern, a new segment is cut and inserted to replace the injured one. The commutator must then be tightened up, heated, retightened and turned.

On the commutator, the point most vulnerable to oil attack is the outer corner. Here the oil has opportunity to enter the mica both from the top surface and from the end. For this reason, it is found that rotting of the mica most frequently sets in at this corner. Experience has proved that a sharp corner is much more subject to attack than a corner well rounded. It is therefore advisable to turn and file off this edge whenever the commutator is trued. It is also a good practice to paint both the corner and end of the commutator as well as the mica end ring with good insulating varnish whenever the armature is out for repairs or at other suitable intervals.

Brass studs and leads connected to them suffer through oil accumulation largely because the oil serves to gather and retain carbon dust and other dirt. A coating of this oily accumulation bridging across the insulation causes leakage which may suffice to set up a small arc, this in turn burning the fiber or other insulation used. It is quite difficult to keep clean a motor subject to oil leakage because the force of a bellows or air hose is insufficient to remove the dirt if it is retained by gummed oil. Cleaning with gasoline is the necessary alternative.

Field coils of a direct-current machine or primary windings of an induction motor may fail because of insulation leakage arising from oil soaked condition. This

commonly occurs at the lower field coil or lower section of the primary winding since the oil accumulates in the bottom of the motor frame and is soaked up from that point by capillary action.

This oil, so detrimental to the electrical portions of machines, comes originally from the bearings, of course, occurring as a leakage along the shaft, out the commutator end ring and thence onto the commutator surface or into the brush rigging. If the outboard bearing is at fault, the leakage is along the shaft, to the armature or rotor spider, thence into the windings. The creepage of the oil is usually attributed to 2 factors, namely, suction and centrifugal force.

Suction is caused mainly by windage in the machine incident to the ventilating system. The air for cooling is generally drawn in at the ends, adjacent to the bearing housings, and is expelled radially from the central portion of the machine. The slight suction resulting from this action is sometimes sufficient to draw oil from the bearings along the shaft and thence to other parts. It will be seen that high-speed machines and those having strong ventilating currents are most likely to be subject to oil leakage. This is found to be the case in practice. Turbine generators, for instance, are particularly liable to this action if provision is not made to prevent it. After having crept along the shaft and out of the bearing, the oil soon reaches a surface normal to the shaft. Here centrifugal force plays a part, quickly conveying the oil radially outward, enabling it again to creep axially onto the commutator and end ring or else throwing it off into the brush rigging. Motors driving fans are sometimes affected by the air currents so that the oil is drawn from the bearings, in this case being carried free from the machine, to be sure. Loss of oil, however, may quickly lead to a hot bearing.

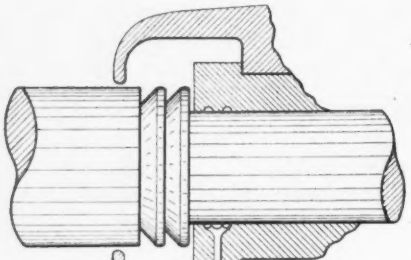


FIG. 1. ORDINARY METHOD OF LIMITING OIL TRAVEL ALONG SHAFT

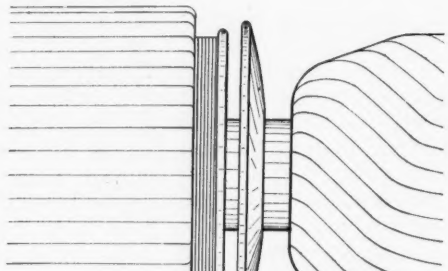


FIG. 2. METHOD OF PROTECTING COMMUTATOR FROM BEARING OIL

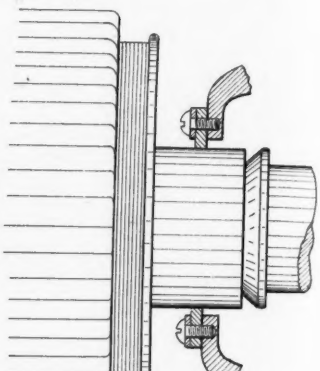


FIG. 3. LOCATION OF OIL WIPING WASHER

The proper place for oil is in the bearings, of course, and some provision is made in all machines to keep it there. These provisions are not always effective, however. Figure 1 illustrates the ordinary methods of controlling and limiting the flow of oil along the shaft and in the bearings. The end of the bearing sleeve is provided with one or more grooves, two being shown in the figure.

These grooves empty into a recess which leads to the reservoir of the oil well. Most of the oil film leaves the shaft at these grooves. A little may travel further along the shaft. It soon encounters an enlargement or shoulder on the shaft beyond which one or more grooves are cut, as shown in the figure. At this point, the action of centrifugal force is employed to cause the oil to be thrown outward and off the shaft. Any oil which reaches the summit of the triangle cannot easily creep inwardly along the bevel, hence it accumulates in drops, is thrown off into the bearing housing and returns to the reservoir.

Failure of this action may be caused by several things. Clogging of the oil channel in the sleeve or in the housing may cause overflow or flooding. An excess of oil when the reservoir is filled to too high a level may lead to trouble. Insufficient depth to the oil grooves in the bearing sleeve may render the groove or grooves unable to handle the oil fast enough, and too small an opening through the sleeve may have the same effect.

Failure of the shaft grooves to remove the oil from the shaft may arise from excess of oil due to one of the preceding causes; or the shoulder or grooves may be of insufficient depth to get good centrifugal action. The remedies for the difficulties here mentioned are obvious, namely: provision of plenty of clear space for the flow off the shaft into the reservoir, care in filling bearings to avoid overflowing them or filling them too full, and enlargement of the shaft grooves, if possible, to increase their effectiveness.

Where these more obvious methods fail, other steps are necessary to stop creepage. If the outer end of the bearing is open, it is well to place a cap over it. This will stop the entrance of air at that point and may eliminate the suction which causes the trouble. A method of protecting the commutator from injury is shown in Fig. 2. Here a metal disk normal to the shaft serves to convey the oil radially outward, preventing its return to the shaft beyond and acting as a fence to stop the axial flow of the oil. These "oil slingers" are to be found quite commonly on turbine generators. Sometimes the outer flange of the commutator end ring is designed with a considerable flare to serve a similar purpose. This method is faulty in that it protects the commutator by throwing the oil into the brush rigging, where it is objectionable, only to a lesser degree.

Complete stoppage of oil leakage, where other means fail, can be brought about by the application of an oil wiping washer as is shown in Fig. 3. A washer of heavy felt or sole leather is cut, the bore being slightly less than the diameter of the shaft outside the bearing. The outer diameter is about 1¼ in. greater, as depicted. A steel washer having a bore perhaps 3/16 in. greater than the shaft diameter is placed outside the wiping washer to hold it in place. Four to 6 holes are drilled and tapped in the bearing housing, care being used to prevent their extending clear through, causing leakage. The washers are slipped over the shaft and fastened in place. It will be found that these wipers absolutely prevent creepage of oil. Felt is perhaps more commonly used for this purpose, but the writer's experience has shown sole leather to be preferable as it is stiffer and retains a snug fit much longer than felt,—almost indefinitely, in fact. Leather is also free from capillary attraction and does not act as a wick to siphon out the oil as felt is prone to do.

Modern Electric Elevators and Elevator Problems*

METHODS OF CONTROL, TYPES OF GEARS AND SAFETY DEVICES. BY DAVID LINDQUIST.

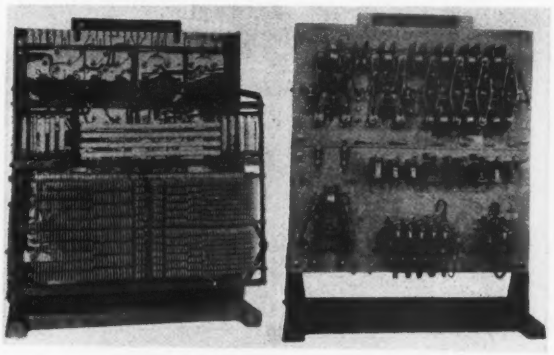
SPEED VARIATION necessary in connection with high-speed traction elevators is obtained partly by field regulation and partly by series and by-pass resistance in the armature circuit. The field regulation is usually capable of reducing full speed down to from 60 to 40 per cent of full speed; further slow-down is obtained by resistance control.

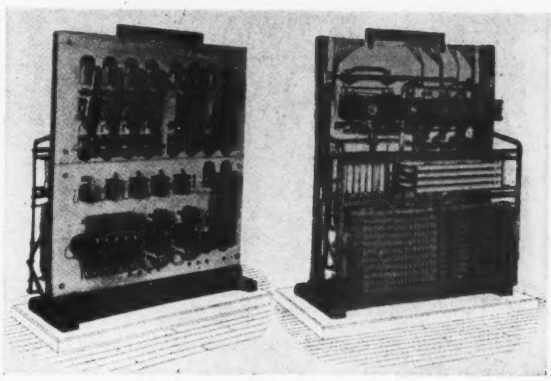
The combination of the 2 methods mentioned is necessary for obtaining sufficiently slow car speed required for making accurate stops both at intermediate and terminal landings, and also in order to make a short travel, or to "inch" up or down, to the landing. Exceedingly slow speed automatically obtained when approaching terminal landings is necessary not only to secure accuracy of stops with varying loads, but to provide a fundamental safety feature.

In connection with the regular operating features of the control apparatus, there are also a number of other features introduced for the purpose of safety. Some of these may be merely mentioned without going into detail: (*a*) Automatic return of car switch to "off" position. (*b*) Automatic stopping switch on car for automatic stopping at terminal landings. (*c*) Final cut-out limit switches in hatchway operating independently of the automatic stopping switch. (*d*) Switches operated by centrifugal governor automatically stopping the elevator in case of overspeed; the first switch cuts the power off from the machine and applies the dynamic brake effect to the armature, and applies the mechanical brake to the brake pulley; the second switch applies the light retarding force to the car safety referred to later under the subject of electro-mechanical safety. (*e*) The safety switch in the car under the control of the operator also performs the same function as the 2 switches operated by the governor. (*f*) Regulation of shunt field by centrifugal governor to maintain constant full speed with variable loads. (*g*) Oil buffers as previously mentioned, capable of independently stopping the fully-loaded car when descending at 50 per cent excess speed without discomfort to the passengers. (*h*) For high-rise elevators the use of a mechanical retarding and latching device.

LOADS AND SPEEDS

GEARLESS TRACTION MACHINES, utilizing 1:1 or 2:1 roping, have been built for loads varying from 2000 up to 11,000 lb. at car speeds from 350 up to 700 ft. per min. Of these duties the most generally used for the modern high office building, utilizing 1:1 roping, is about 2500 lb. at a speed of 600 or 700 ft. per min., although in many instances, a speed of 500 to 550 ft. per min. is found suitable.





FIGS. 3 AND 4. TYPICAL CONTROLLERS USED WITH TRACTION ELECTRIC ELEVATOR MACHINES

For more moderate speeds and heavier loads, a 2:1 roping of car and counterweight is utilized (shown diagrammatically in Fig. 5), which retains the safety features and general characteristics of the 1:1 equipments. For moderately high buildings, this 2:1 roping is suitable for a car speed not in excess of 450 ft. per minute.

GEARED MACHINES

THE TRACTION PRINCIPLE is also applicable to elevator machines employing moderately high-speed motors with some form of gearing between the motor and driving

*Abstract of paper read before the A. S. M. E., continued from page 375, April 15 issue.

sheave. Machines of the geared type are most suitable when lower speeds are involved or where the service conditions are not so severe. Under these conditions the power consumed will be comparatively small on account of the lesser mileage, and hence the more expensive gearless machine with its reduced power consumption may not be necessary.

As far as smoothness of operation is concerned, a geared machine can obviously never equal that of a gearless, on account of the fact that it is practically an impossibility to manufacture any kind of gears which are perfect, and mount the same in absolute alinement. Furthermore, if this condition of perfection could be established, it could not be maintained in service, on account of the inevitable wear that would take place.

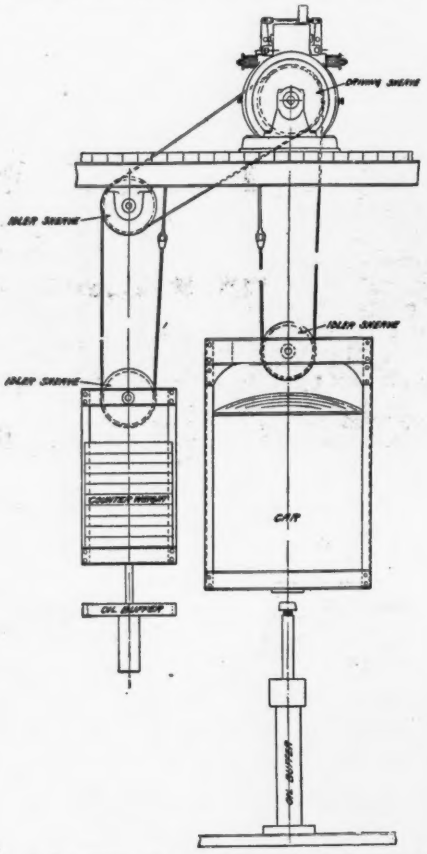


FIG. 5. 2:1 ROPING OF A GEARLESS TRACTION ELEVATOR

Two types of geared machines have been developed, one employing worm gear and the other herring-bone gear reduction. See Figs. 6 and 7. Of these 2, the worm-geared is suitable for slow and more moderate speeds, and is used extensively for this purpose. The machine with herring-bone gear reduction is of course not suitable for slow car speeds on account of the difficulty in obtaining sufficient speed reduction. Undoubtedly, it is somewhat more efficient than worm gearing, and has been used with some success in connection with quite high-speed elevators. The fact that the herring-bone geared machine has been used for these high speeds should not be understood as indicating that it is equal to the gearless machine, with which it cannot compare as to operating features and power consumption.

Of the 2 kinds of gears mentioned, the worm gear has inherently less tendency to vibrate than the herring-bone gear. On the other hand, the herring-bone gear is generally more efficient than the worm gear.

Power Consumption

Considerations of power consumption in the machine may be divided into 3 parts relating respectively to motor efficiency, gear efficiency and inertia. The maximum efficiency of the high-speed motor used in connection with the geared machine may occasionally be as high as that of motors used with the gearless, but the efficiency at lighter loads, which is the normal service condition, is lower; hence the high-speed motor is at a disadvantage. An equal amount of field regulation may be applied to both high- and low-speed types of motors. High-speed motor machines may be considered to have, under the best conditions, a gear loss of about 10 per cent, whereas this loss is entirely eliminated in the gearless machine. Although kinetic energy is the most important factor in power consumption, it has in

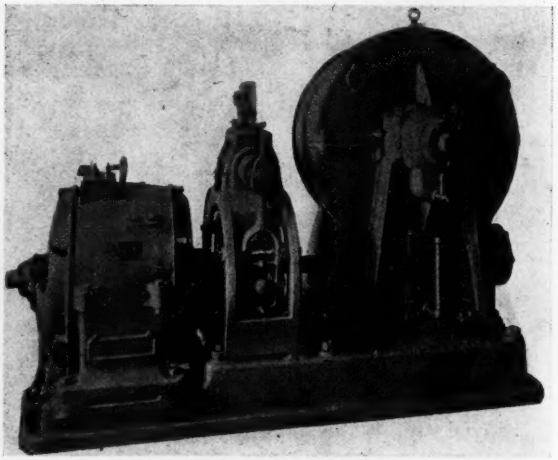


FIG. 6. A GEARED TRACTION ELECTRIC MACHINE USING WORM GEARING

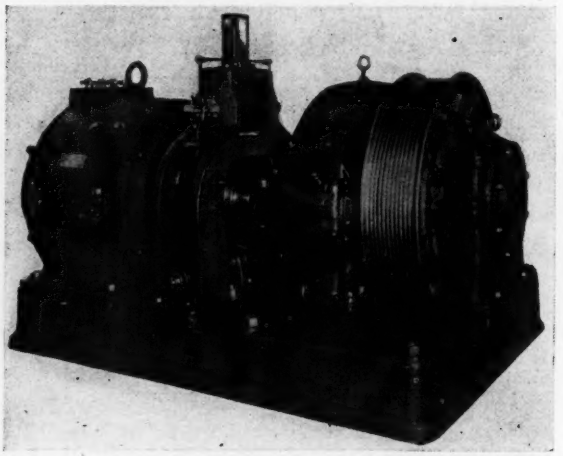


FIG. 7. A GEARED TRACTION ELECTRIC MACHINE WITH HERRING-BONE GEARING

the past been apparently little considered, due probably to difficulty in readily determining its amount, in a rather complex elevator machine.

Electro-Mechanical Elevator Car Safety

The essential requirement of an elevator car safety is to stop and hold an elevator car under all conditions of load and speed, whether the hoisting ropes are intact or parted. Figure 8 illustrates the safety device usually employed until a comparatively short time ago, and which, even at the present time, is still installed. It is the standard so-called wedge clamp safety, which clamps the rails for retarding and holding the elevator car in case of overspeed or free fall.

Present practice utilizes the same principle of application whether the safety is actuated under conditions of excessive speed with hoisting ropes intact or during free falling. A strong retarding force is required to stop a free-falling car, but this strong retarding force, if applied with ropes intact, is excessive and will give an unpleasant shock to the passengers.

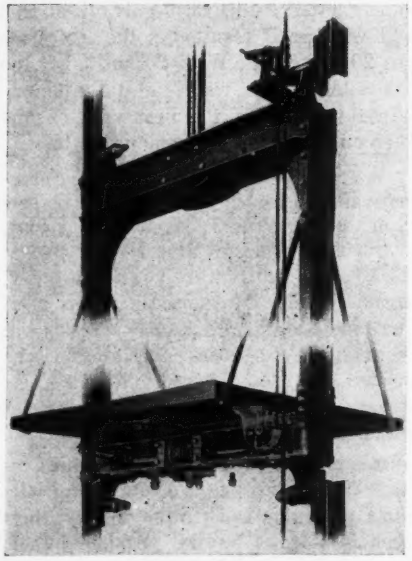


FIG. 8. TYPICAL APPLICATION OF THE WEDGE-CLAMP SAFETY

The car, with all attachments, of a modern high-rise elevator, weighs about 6500 lb., the maximum load is usually 3000 lb. and the compensating ropes weigh about 2500 lb.; the total load to be stopped by the safety with the ropes parted would therefore be 12,000 lb. To insure the stopping of a car, at least 50 per cent excess force should be provided, bringing the total retarding force required up to a minimum of 18,000 lb. Were a major portion of this retarding force applied with the ropes intact, the car would be stopped too abruptly. This would be accentuated with a light load, particularly as the machine brake and strong dynamic action of the motor assist the retarding force of the safety.

For the above-mentioned reasons, it is essential, therefore, that the safety should apply a strong retarding force in case of a free falling car with ropes parted, and a light retarding force in case of overspeed with ropes intact. The principal safety features which should be incorporated in a safety device for high-speed elevators are as follows: (*a*) The safety should be so arranged that the application of a predetermined and definite light retarding force will stop the car and net load without shock in case of overspeed with hoisting ropes intact. (*b*) The safety device should be so arranged that the application of a predetermined and definite strong retarding force will gradually bring the car and maximum load to rest in case of a free falling car. (*c*) The light retarding force should be immediately applied, preferably by means of a centrifugal governor, in case the car should attain excessive speed in either direction. (*d*) It should be possible to apply immediately the light retarding force from within the car, when desired. (*e*) The light retarding force should be applied automatically in case of overrun at the upper or lower terminals,

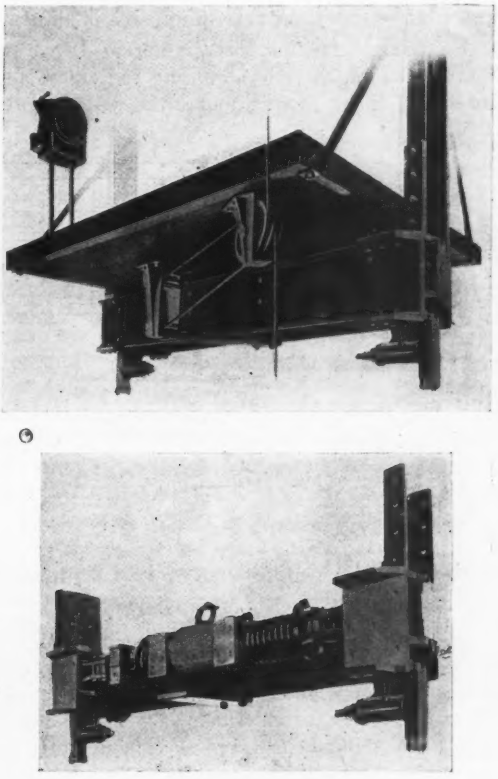


FIG. 9. DETAIL VIEWS OF AN ELECTRO-MECHANICAL WEDGE CLAMP SAFETY

and yet be so arranged as not to interfere with the starting of the car in the opposite direction. (*f*) The strong retarding force should start to apply the instant the hoisting ropes part, independently of the speed of car and counterweight. (*g*) A tripping governor should not be necessary to apply the strong retarding force, except on safelift machines. (*h*) In the case of safelift machines, a strong retarding force should be automatically applied independently of the parting of the hoisting ropes, at a definite speed which should be higher than the speed at which the light retarding force is applied. (*i*) The releasing carrier, even when improperly adjusted, should not prevent the application of a strong retarding force to the car in case the ropes part. (*j*) The

principal actuating parts of the safety should be made to move automatically at frequent intervals, in order to prevent them from clogging up or corroding together; this motion of the actuating parts need be only small, to give the desired results, but some motion is necessary to secure dependable action of the safety.

Figures 9 and 10 show the general features of an electro-mechanical elevator car safety which embodies all of the above described requirements. The light retarding force is obtained by means of a helical steel spring forcing the wedges between the rollers of the safety jaws. When the car is in service this spring is held under compression by means of an electro-magnet. The instant the current in this magnet is interrupted, either by the centrifugal governor, safety switch in car or limit switches in the hatchway operated by the car or counterweight, the light retarding force is applied.

The strong retarding force is obtained by revolving the safety drum, thereby actuating the right- and left-hand screw, which in turn moves the wedges and forces

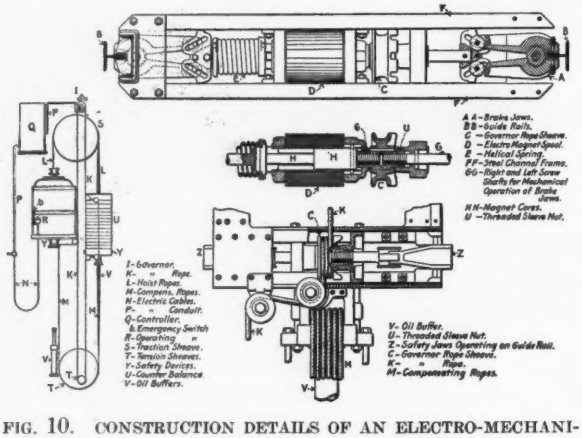


FIG. 10. CONSTRUCTION DETAILS OF AN ELECTRO-MECHANICAL WEDGE CLAMP SAFETY

the jaws against the guide rails. The strong retarding force is definitely determined by the number of turns around the safety drum, which vary in number according to the maximum load and the amount of the safety rope tension weight.

The releasing carrier is placed on the counterweight and will therefore apply the strong retarding force of the car safety, even though the releasing carrier fails to release, due to faulty adjustment. The strong retarding force only is applied to the counterweight safety.

Whenever the current is cut off from the elevator, the electrical parts of the safety are operated, thereby applying the light retarding force. The mechanical actuating parts of the safety effecting the strong retarding force are continually kept in slight motion when the elevator is in operation, due to the different stretching of the hoist and governor ropes. It is possible to remove all parts without disturbing the car platform, enclosure or car frame, thereby assuring easy access for inspection. In case of safelift elevators, a strong retarding force as described under *h* is applied by means of a parallel jaw double acting governor.

Small Electric Station Systems

INTERESTING data pertaining to electrical stations was given in a paper read before the Western Society of Engineers at its April 24 meeting. It was stated that 4700 electric stations are located in cities of less than 50,000 inhabitants. Of this number 15 per cent generate direct current and 85 per cent generate alternating current. Data obtained from 489 stations classified the current generated into 22 different combinations of voltage, frequency and phase as shown in the following summary:

Phase: 39%, 3-phase, 3 wire; 24%, single phase; 23%, 3-phase, 4 wire; 14%, 2-phase, 3 and 4 wire.

Voltage: 17%, 1100 volts; 58%, 2200 volts; 2%, 115 volts; 24%, 4000 volts.

Frequency: 90%, 60 cycle; 2%, 25 cycle; 0.6%, 40 cycle; 6.4%, 125 and 133 cycles, etc.

For a 3-phase distribution system of an electric station located in the middle west, and carrying small, widely distributed load, No. 6 galvanized iron wire was employed with good results, as the losses amounted to less than 20 per cent. With 20 and 30-ft. poles spaced 40 to the mile, the cost was $450 per mile, or $16.50 per capita. At the end of the first year of operation the net return on the investment amounted to 12.57 per cent.

IN THE annual report of the American Telephone and Telegraph Co., a resume is given of the program in telephony which summarizes clearly the progress of this method of speech transmission. In the development of the transmission by wire circuits it has been the effort so to arrange the long distance systems that existing instruments and subscribers' lines and switchboards may be connected to any of the long distance lines, thus making the long distance facilities available to the greatest number.

Experiments on wireless transmission of speech have been made by the company, co-operating with the Navy and War Departments, which have given the use of their large wireless towers for the purpose. In spite of the fact that the long distance wireless transmission is accomplished, it is likely to be of use only in special cases. The power necessary at the transmitting station increases rapidly with the distance to be covered, as the vibrations have great volume and intensity. They diminish rapidly, however, as they pass onward, except as to definiteness, and at a distant receiving station they are very faint, but if static conditions permit and no artificial electrical disturbances are involved, the signals can be picked up and transferred to a receiving instrument or to a land wire for further transmission. If the receiving and transmitting stations were to be located at the same point, as is the case on wire lines, so long as transmission is going on the receiving apparatus would be unavailable, for the vibrations of the incoming messages would be destroyed by those of the outgoing messages.

In wireless transmission there can be no such thing as secrecy, for although wave lengths of the vibration may be varied to a certain extent, any receiver can be adjusted to any wave length and, in order to avoid humming and interference, the wave lengths to be used simultaneously must be of a considerable difference.

Foreign Development in the Power Plant Field

NEW ELECTRIC LAMP; THE METRIC SYSTEM IN ENGLAND. BY J. H. BLAKEY.

THE Edison and Swan United Electric Light Co. of England has brought out a new form of arc lamp, which is contained in a glass bulb, similar to the ordinary incandescent lamp, and in which the carbons are not consumed. Since 1913, the company has been making experiments with this end in view, the lamp having electrodes of tungsten or other suitable refractory material, and the arc being produced in an inert gas, such as nitrogen or argon.

In the first experiments the electrodes were in contact at the moment of ignition, and their separation was obtained by the action of a dilatation piece formed of a plate of molybdenum to which had been soldered a plate of copper. The dilatation piece was heated by means of a filament of tungsten enrolled spirally and mounted in series in the circuit of the arc. The light was very steady, of a dazzling white; but the principal defect of the lamp was that the electrodes, each formed of a globule of tungsten, stuck together so that when they finally separated they were broken. After numerous experiments, a lamp was produced which burned for 100 hr.

The solution of the difficulty was then attempted in another way, by keeping the electrodes at a fixed distance from each other by the introduction, close to them, of a tungsten filament called an ionizer. This ionizer, brought to incandescence, gave a strong negative discharge, and ionized the space between it and the electrodes. With the alternating current good results were obtained, the ionizer filament being mounted in parallel with the arc; a unipolar interrupter and an appropriate resistance being suitably arranged. When the lamp is lighted the ionizer circuit is closed for some moments, and an arc is formed between the ionizer and one of the electrodes; then the ionizer circuit is opened and the arc is formed between the 2 electrodes.

With the direct current it is difficult to cause the arc formed between the ionizer and the positive electrode to pass to the negative electrode. Consequently, the idea of the 2 tungsten electrodes was abandoned, and the arc is formed between an electrode and the ionizer. But then the filament rapidly lost its ionizing properties.

Experiments were then made to find a new form of ionizer filament by mixing tungsten with certain refractory oxides, and a material was finally obtained which has greater ionizing properties, but at the end of 200 hr., these were destroyed as the result of the continuous passage of the arc. In order to avoid this, the idea was tried of lightly displacing the electrode after illumination, so that the arc was produced at another point of the ionizer and that the part from which the arc springs was not worn away; the displacement of the arc being obtained by arranging above it a small dilatation piece, which it heats and which by its elongation produces the necessary displacement. By this means, lamps have been produced which burn for 500 hr., and it is believed that an 800-hr. lamp will soon be perfected.

In a direct-current 100-c.p. lamp, 3 conductors pass through the socket; 2 of these communicate with the positive pole, one ending at the positive electrode formed by a globule of tungsten, while the other terminates at the end of the ionizer filament, of which the other end is connected with the negative conductor. The positive conductor which connects with the ionizer passes by the contacts of an electromagnetic interrupter whose winding is arranged in the circuit of the positive conductor which terminates at the electrode. When the lamp is lighted the current passes in the circuit of the ionizer, which is brought to incandescence; a current of rapidly increasing intensity passes between ionizer and electrode, and the arc is produced; the automatic interrupter now acts upon the ionizer circuit, the dilatation piece lengthens and the arc is displaced. In this lamp all the light emanates from a globule 2.5 mm. (1/10 in.) in diameter.

In high power lamps the dilatation piece can be dispensed with; the electrode is rather thick and of rectangular section. This is arranged parallel to the ionizing spiral, and the arc forms at its edge. As the arc tends to pass by the shortest path, it is displaced along the edge of the electrode. In a high power lamp, a small auxiliary positive electrode can also be used in such a way that the arc is first formed between the ionizing filament and this electrode; then the large positive electrode is put in circuit; at the same time, by means of a commutator, the auxiliary electrode is made negative, and as it is incandescent, an arc is formed between it and the large positive electrode. By this means, electrodes of large dimensions can be used.

The light of the lamp is steady, white, and the luminous surface is very small, so that its intrinsic brilliancy is considerable. For this reason, it is well adapted for use in projection apparatus. The consumption is ½ watt per candle, and it can stand variations of tension up to 25 per cent without injury.

AGITATION FOR THE ADOPTION OF THE METRIC SYSTEM IN ENGLAND

IN CONSEQUENCE of the reports of traveling salesmen sent out by English manufacturing firms that it is impossible to get orders in the European countries unless goods are described in metrical units, the Electrical World of London, England, is carrying on a campaign for the adoption of the metric system in England. With this end in view, letters have been sent out to manufacturers containing the following questions:

1. Do you use the metric system in your foreign correspondence?

2. (a) Are your goods described in your catalogs in metrical units, and (b) the prices given in a decimal system of coinage?

3. Do you use the metric system in your workshops?

4. Are you in favor of the adoption in this country of (a) a decimal system of coinage, and (b) the metric system of weights and measures?

The answers received were as follows:

Question.	Yes.	No.	Doubtful.
1	86	25	10
2 (a)	56	51	14
(b)	41	62	18
3	61	54	6
4 (a)	79	20	22
(b)	87	21	13

From this it will be seen that the metric system is now in use in about one-half of the establishments to which the letters were sent. As to the last question, more than 4/5 of the total number replied in the affirmative: that is, they wish the adoption of the metric system and also a decimal monetary system in England.

In 1903, letters were sent out to directors of schools, requesting an opinion as to how much time would be saved in the education of students if the metric system were adopted. In answer the directors estimated the time that would be saved at from one to three years. In 1914 the same inquiry was sent to various Chambers of Commerce, and of the 41 replies received, 40 were in favor of the adoption of the metric system. For many years past, English consuls in foreign countries have been urging this change, as the only means of competing successfully with their commercial rivals, and this applies especially to the trade in machinery.

In the Baldwin Locomotive Works, in this country, an order was received some time ago for 20 locomotives for France. As the time of delivery was so short, it was decided to use the metric system in their manufacture, instead of changing the dimensions on the 500 drawings supplied by the Compagnie d'Orleans. The result is that all the workmen employed on this contract, as well as the superintendent, have become enthusiastic advocates of the metric system.

The English cling to their superannuated systems largely from love of tradition. But everyone agrees that many traditions will be swept away by the war and it is believed that this will be one of them. It has been asserted that it is national pride that prevents the adoption of a system which has been so long in use on the continent. Thus, some of the magazines and newspapers have been trying to spread the idea that it was the Englishman, James Watt, who invented the metric system, evidently with the object of inducing its adoption without any loss of national pride.

Novel System of Flood Lighting

FLOOD lighting of the Sheepshead Bay Automobile speedway, and the 160-acre interior field, will make it the largest illuminated area in the world for holding nighttime outdoor sporting activities, auto races and military maneuvers. An initial installatoin of 370 G. E. flood light projectors, each with a 500-watt, gas-filled Type C Mazda lamp, will be used to illuminate this large space.

The Sheepshead Bay race track is just out of New York City, near Coney Island. The 2-mile track is 70 ft. wide, inside of which is a 30-ft. safety zone. The oval field contains nearly 160 acres of turf. This largest and finest auto speedway is constructed of heavy plank, 2 in. thick and 10 in. wide, placed edgeways and banked 25 ft. at each turn. The interior field will be lighted from 224 flood light projectors spaced all around the outer edge and directed upon the field. These units will be installed on poles 30 ft. above the track and will give an even intensity illumination over the total field of approximately 50 to 100 times full moonlight. This intensity will be further increased in the section just opposite the grandstand by focusing 114 additional flood lighting units on this space, the projectors being located at the top of the grandstand and well out of the line of vision. Thirty-two additional flood lighting units will be installed to light the fences.

The 224 projectors around the 2-mile track are arranged so they can be readily turned upon the race course, producing a ribbon of light for the entire 2 miles of 70-ft. track and the 30-ft. safety zone. With this arrangement all light sources will be hidden from the eyes of the drivers and the light will come from both sides of the track, always flooding ahead and in the same direction as the speeding machines.

Flood light projectors are to be arranged so that any number of lights can be turned on or off at any time, independent of the others, so as to give a certain section brighter intensity of illumination, or a lower degree, if desired. The flexibility of the light units allows for a narrow beam of high intensity, or a beam of less intensity, and the fact that the beam can be easily directed either up or down, or sideways, makes it adaptable to all conditions. For instance, the lights can be turned up in the air so as to pick up aeroplanes 500 ft. above ground. Immediately opposite the grandstand will be a parking or repair area for disabled automobiles or those which have to drop out of the race for any reason. This "pit" will be illuminated to approximately twice the intensity of the track, so the audience will be able to witness this interesting part of the race.

In addition to the 24-hr. automobile races scheduled for the middle of June on the Sheepshead Bay Speedway, National Guard military maneuvers will be held from May 20 to 28, when over 10,000 men will drill in the illuminated area. Historical pageants, athletic events, a cowboy "stampede," etc., will also be held at night during the coming summer. Heretofore really big outdoor events could be held only during the daytime, and not at night, when most people have both the time and inclination for amusement.

Flood lighting projectors will be furnished by the General Electric Co. Current will be supplied by the Brooklyn Edison Co., and will be distributed at 3 points, the largest feeder being near the grandstand, where most of the current will be used. A 200-kw. transformer will step the current down from 2200 to 100 v., 60 cycles, at the grandstand, and 2 100-kw. transformers will be used for this purpose at the other feeding points. A contract has already been signed for 50,000 kw.-hr. for the first year, and in a year or more it is expected the load will reach 200,000 kw.-hr. per year.

THE CITY OF Lima, Ohio, has voted a bond issue for $700,000, of which $500,000 is to go for boilers, a 12,000,000-gal. pump and other necessary equipment; $100,000 will be used for additional retaining walls, dam, river deepening, etc., and another $100,000 for street paving and possibly an asphalt plant. The work will start in approximately 30 days.

GAS POWER APPARATUS

Producers, Engines and Industrial Applications

Gas Producer Control. I.

THERMOSTATIC REGULATION OF AIR TEMPERATURE AND OF GAS QUALITY IN A SUCTION PRODUCER WITH LOAD VARYING. BY REGINALD TRAUTSCHOLD

RECENT CANVASS of establishments operating on producer gas showed almost universal satisfaction on the part of the management with this method of power production. Excellent economy was reported in the majority of instances and the statement frequently made that, if the plants were to be rebuilt, the same type of power would be installed. This is quite different from what would have been the result of such a canvass but comparatively few years ago, and is particularly noteworthy in view of the fact that during this same period in which producer gas has made such strides, the steam engine, the steam turbine and the oil engine have also shown considerable improvement in efficiency and in economy of operation.

Progress made by the gas producer has been not so much in increased economy under definite service, for some of the earliest gas producers showed excellent economy under certain favorable conditions, but rather in increased reliability. Gas supplied to the engines by a modern high class suction producer is much more uniform in quality than was the case with the earlier producers, notwithstanding the fact that gas consumption by the explosive engine differs considerably for varying degrees of load. For instance, under half load the average gas engine requires nearly 1/3 more gas per horsepower than when operating at full load; while at 3/8 load over 50 per cent more gas is required per horsepower.

PRODUCER REACTIONS

FOR SATISFACTORY gas engine operation, the fuel should be of the same quality at all degrees of load. A gas producer, to prove economical and efficient, is further called upon to generate its gas only at the rate required by the engine, so it must be sensitive to any variation in load on the engine. The demands are exacting and can only be realized when the reactions taking place in the producer are automatically regulated and the supply of the mediums producing the reactions are controlled by the engine.

These reactions are two, and in two zones: First, a zone of complete combustion of the fuel charge, which develops the heat by which the volatile constituents of the fuel are driven into a zone where there is insufficient oxygen to complete combustion; this complete combustion also keeps the mass of carbon, or fuel, in the second zone, in such state of incandescence that the second reaction may take place. This second reaction consists simply in the combination of the carbon dioxide resulting from the complete combustion of the fuel with the carbon of the incandescent fuel bed, as it passes through, a reducing or negative reaction producing carbon monoxide.

These two chemical processes represent the entire operation of a gas producer, but physical conditions control their performance. The reaction of the carbon dioxide to carbon monoxide, the second reaction, absorbs a certain amount of heat, but not as much as is liberated by the initial complete combustion of the fuel in the first reaction, the ratio of heat absorbed to that liberated being about 1 to 3.2. This would rapidly result in the fusing of the ash and the destruction of the producer, unless some heat absorbing medium were supplied for keeping the temperature of the fuel bed at a suitable point. It is true, the inactive nitrogen constituent of the air required for the first reaction does tend to keep the temperaure of the fuel bed from an even greater elevation, but this is not sufficient. Another heat absorbing medium must be supplied.

WATER VAPOR COOLING OF FUEL BED

WATER VAPOR, or steam, is the cooling medium most commonly employed. This, supplied in correct proportions, not only keeps the temperature of the fuel bed from rising above the danger point, but may even enrich the gas to some extent by the addition of a small amount of hydrogen, or various hydrates. Oxygen of the water, if the temperature of the fuel bed is sufficiently high, may combine with the incandescent carbon to form, first, carbon dioxide and, subsequently, carbon monoxide, the hydrogen being liberated meantime, passing through the scrubber, and becoming intimately mixed with the other power gases or combining with the carbon to form hydrocarbons. This, at least, is the claim made by the advocates of gas producers employing water vapor for the cooling medium, and, though it would seem doubtful whether any appreciable amount of water vapor is actually broken up into its component elements, there is no question that water vapor is an excellent cooling medium for suction gas producers.

Temperature of the fuel bed, upon which the first or positive reaction depends, is naturally controlled by the amount of air admitted to the producer, and for this simple automatic regulation is controlled by the engine exhaust. An induced draft is created, through suitable

connections, which is directly proportional to the fuel consumption of the engine and therefore regulated by the degree of load on the engine, the regulation being particularly sensitive to any variation in load as long as the engine itself is efficiently regulated. This regulation is positive and entirely automatic. Once the volume of air required for any load is correctly ascertained, usually at the time the installation is made, no further adjustments are necessary, if the quality of the gas produced is kept constant.

Economy of operation of any suction gas producer in which the positive reaction is controlled by the exhaust of the engine is then largely dependent upon the efficiency and sensitiveness of the second or negative reaction. This must also be automatically regulated to the degree of load on the engine. It was failure to accomplish this that caused the unreliability of the earlier gas producers and it is upon the sensitiveness of this regulation that the economy and generally satisfactory operation of the modern suction gas producer also depend.

In the early type of producer, the supply of water vapor, which is the cooling medium still most generally used, was furnished from some independent exterior source, the steam being allowed to pass through the fuel bed with the air supplied for the preliminary combustion, giving the positive reaction. Sensitive regulation of the water vapor supply was impossible; in fact, the supply was necessarily maintained about constant, so that for light loads the fuel bed was cooled too much, and for heavier engine loads not enough. This naturally resulted in the production of a varying gas which made satisfactory operation well nigh impossible.

Mechanical regulation of the air supply, which, if accurately accomplished might maintain a fairly uniform *quality* of gas, disturbed the correct supply of gas, as the necessary volume was either decreased or increased, so that little, if any, improvement in general operating efficiency was realized.

Vapor Control

Air at a fixed temperature and under a given pressure can only absorb a certain quantity of moisture, for saturated air always contains the same amount of water under similar conditions of temperature and pressure. This offered the solution to the problem; for the quantity of water vapor required by the producer was comparatively small, only a fraction of a pound per pound of fuel consumed by the producer, and the necessary volume of air comparatively large and automatically regulated by the engine. Sensitive automatic control of the water vapor supply by the variation of load on the engine is thus secured, when once the correct temperature of the saturated air supplied to care for both the positive and the negative reactions is ascertained.

Exact temperature of the saturated air with which the highest producer efficiency and economy can be secured varies to some extent, it is true, depending upon the quality of the fuel used and the proportions of the producer. This temperature should be ascertained through experiments at the time of installation of the unit and, if maintained constant during subsequent operation, the economy of the producer under any degree of load will, automatically, be maintained at a maximum.

This charging with water vapor of the air supplied for the positive reaction of the producer is now almost universally employed, and is accomplished in divers ways. One successful producer, the Smith, utilizes the hot water discharged from the engine jackets. This hot jacket water is heated still further and passed to a saturating chamber in which it is intimately mixed with the air destined for the producer, so that the air drawn from the saturating chamber and through the producer by the exhaust of the engine is laden with water vapor to the point of saturation. Other producers, as the Akerlund and Otto, saturate their air supply by causing it to circulate in chambers over water jackets within the producer shells, the jackets continually emitting water vapor, which is as continually absorbed by the air circulating over the jackets and automatically drawn through the fuel bed, fully saturated and in the required volume.

So sensitive is the regulation by the air saturation method and so readily does the consumption of fuel by the producer respond to such control, that extreme care must be taken to have no variation in the temperature of the saturated air fed to the producer. The importance of this does not seem to be generally recognized, and it is failure to observe this apparently trivial requirement which has led to some dissatisfaction in producer gas installations. Also to this neglect may usually be traced the failure of the producer to operate as economically as would reasonably be expected. (To be continued.)

What is a Semi-Diesel Engine?

Definition and Historical Sketch; Construction; Characteristic Features. By C. S. Salfeld

DURING recent years the term "Semi-Diesel Engine" has frequently been misapplied to hot-bulb engines generally, especially those of the 2-cycle type, as if, ridiculous to say, a 2-cycle engine were a nearer approach to a Diesel engine than a 4-cycle engine. In consequence, considerable criticism has been raised in the technical press.

Fuel injection by means of compressed air is not a criterion of the Diesel engine. The distinguishing features are solely the (a) presence in the cylinder of pure air alone during the compression stroke so as to obviate pre-ignition, (b) a compression pressure sufficiently high to prevent a material rise of pressure upon injection of the fuel, and (c) the gradual injection of the fuel commencing shortly before and finishing after the inner (or upper) dead center so as to ensure the desired slow combustion.

The injection of the fuel may be effected with compressed air or without it, provided the injection is gradual. If the whole of the fuel is injected before or at the dead center, the resulting engine is not a "slow-burning" or Diesel engine, but an "explosive" or "constant volume" engine. The Brons, St. Marys, and Nordberg engines belong to that category.

A semi-Diesel engine, as the name implies, is a modification of the parent engine, the modification in every case being a simplification, not necessarily conducive to greater efficiency, but to lower first cost. There are now existing 2 distinct types of semi-Diesel engines differing

only in the number of features taken over from the true Diesel type, and this difference merely resolves itself into the kind of fuel injection used.

The semi-Diesel engines with compressed air injection, as represented by the De La Vergne Type FH and by the Blackstone crude oil engine, bear their right to the name. These engines differ from the true Diesel solely in the elimination of the high-compression feature and the substitution, in its place, of an uncooled bulb attached to the cylinder head.

The semi-Diesel engine, with ordinary pump injection, the best example of which is the "complete combustion engine" of Messrs. Ruston, Proctor & Co., Ltd., Lincoln, England, has usurped its name. Whether of the 4-cycle or 2-cycle variety, with or without water injection, it was—beyond the slightest doubt—invented 25 yr. ago by Herbert Akroyd Stuart.

The history of the Akroyd engine is interesting. In 1891 a 6-hp. engine of this type was tested by Prof. W. Robinson, of Nottingham. The injection of the fuel took place close to the inner dead center just as in the modern "semi-Diesel." The compression pressure, however, which is now at least 150 lb. per sq. in., was at that time only 45 lb. per sq. in., the explosion pressure, therefore, did not exceed 120 lb. per sq. in., and the mean effective pressure was 35 lb. per sq. in. The consumption of gas oil of 0.853 sp.gr. and 225 deg. F., flash-point was at the rate of 1 lb. per brake horsepower-hour.

During the same year, 1891, Messrs. Richard Hornsby & Sons, Ltd., of Grantham, England, acquired the patent rights and commenced to manufacture the engine under the name of the "Hornsby-Akroyd." The first thing they did was to destroy the character of the engine. They arranged for the fuel injection to occur early during the suction stroke instead of at the end of the compression. It must be carefully kept in mind, therefore, that the early "Akroyd" engine and the "Hornsby-Akroyd" were totally different in their action. The latter was rapidly improved, found great acclamation and became the prototype of the modern hot-bulb oil engine, but the "semi-Diesel" had been killed in its cradle. Twenty years later, in 1911, Messrs. Hornsby resurrected the original design and brought out their present "semi-Diesel" known as the Hornsby Type R.

Although Herbert Akroyd Stuart should, therefore, be given full honors for the creation of the present day semi-Diesel engine, his additional claim to the invention of the true Diesel cannot be sustained. The apparatus for the injection of the fuel employed both by him and by Messrs. Hornsby, and later by a host of other manufacturers, does not operate satisfactorily beyond a comparatively low compression pressure, the limit being in the neighborhood of 200 lb. per square inch. Moreover, gradual combustion cannot be obtained by its use.

The name Akroyd fell into oblivion, partly because its bearer went abroad, but more so because, in 1905, on the expiring of the original patents, Messrs. Hornsby discontinued its use. The American makers did not follow suit but retained it so that this old English name is now better remembered in America than in its own country.

In 1910, certain English manufacturers found that with a modified and improved Akroyd system an economy could be obtained closely resembling that of the Diesel engine, a result which justified their decision to adopt the term semi-Diesel. In doing so they did not intend to slight the Akroyd merit for the simple reason that they never thought of it or had forgotten all about it, if ever they had known of it. It must be remembered that the Akroyd engine had never been produced commercially, certainly not by Hornsby's.

What is a satisfactory definition of the "semi-Diesel" assuming it to apply to certain of those engines wherein compressed air injection is no longer used?

The principal feature common to all semi-Diesel engines of this class is the compression of pure air, and the injection of the fuel shortly before the dead center with the result that the rated load can be developed without water injection, although the admission of water may improve the economy. Engines injecting the fuel at about half stroke and compressing a mixture of oil vapor and air are evidently not semi-Diesel engines because they employ not a single feature of the true Diesel type, however good their economy may otherwise be. Besides, these latter engines are distinctly unreliable in their

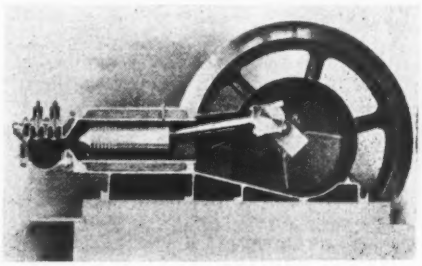


FIG. 1. SECTIONAL VIEW OF DE LA VERGNE TYPE D H OIL ENGINE

action because for satisfactory operation they depend upon a generous supply of injection water and, should that fail, there would occur something akin to an accident, or the engine would stop.

The second feature characteristic of a semi-Diesel engine is its remarkable economy, ranging from 0.45 lb. per brake horsepower-hour in the best types to 0.55 lb. per brake horsepower-hour in the less efficient types. This economy is dependent on the size of the engine, whether 4-cycle or 2-cycle, and on the compression pressure used. The latter must needs be 150 lb. per sq. in. or more, and is frequently found between 200 and 300 lb. per sq. in. Two-cycle engines are throughout less economical than 4-cycle engines, and in their case it may perhaps be admissible to draw the lower limit of economy, particularly in the smaller sizes, at 0.6 lb. per brake horsepower-hour. No further allowance can be made, for the simple reason that a consumption of 0.6 lb. per brake horsepower-hour is within the scope of any ordinary oil engine not operating upon the semi-Deisel plan.

The last stipulation operates to exclude from the designation "semi-Diesel," a number of engines which, though actually injecting the fuel at the end of the compression stroke against a pressure of 150 lb. per sq. in. or more, yet show a fuel consumption varying between the limits of 0.75 and 0.85 lb. per brake horsepower-hour. Such low efficiency is merely due to a lack of knowledge resulting in faulty details, but with proper

care such defects may be eliminated and these engines be raised to the level of a modern "semi-Diesel."

To make the position quite clear it will be well to cite an example. Fortunately we need no longer go abroad to find specimens of the 4-cycle semi-Diesel type without compressed air injection. The De La Vergne Machine Co., in their new "Type DH" oil engine, have a type developed upon the lines of the aforementioned "complete combustion engine."

From the longitudinal section shown in Fig. 1, it will be noticed that the combustion chamber consists of the same elements that make up the regular Hornsby-Akroyd vaporizer. The bottle neck, the water-jacketed part, and the hot cap, all are old acquaintances though rearranged in different form. The air inlet and exhaust valves are both located within the vaporizer, thereby differing from the Hornsby-Akroyd. Their disposition,

FIG. 2

FIG. 3

FIG. 2. INDICATOR DIAGRAM OF DE LA VERGNE TYPE D H OIL ENGINE

FIG. 3. INDICATOR DIAGRAM TAKEN FROM THE "COMPLETE-COMBUSTION" ENGINE OF MESSRS. RUSTON, PROCTOR & CO.

however, is such that, in all probability, no induced scavenging is obtained, nor are the products of combustion expelled from the lower part of the vaporizer during the suction stroke of the engine.

In the Hornsby-Akroyd engine the vaporizer is not cleared of the inert gases to prevent a premature mixture of the oil vapor with the air. The advantages gained are absence of pre-ignition and back-fires; the price paid is a low mean effective pressure.

The side-by-side arrangement of the valves on top of the vaporizer resembles somewhat that used in the Hornsby Type R, but it is much simpler. In the latter engine 3 valves are used, all above the combustion chamber, viz.: the air inlet valve, the exhaust valve, and the "deflector valve," the last being the only one communicating with the cylinder, the first 2 being placed within the "deflector" passage. The advantages of such a complicated arrangement as the last named are more imaginary than real. For this reason, evidently, the De La Vergne Co. refrained from applying it.

The cylinder head is cast open at the top, and is closed by a separate flange, to allow of easy access to the water-jacket. This construction has become a recognized feature in European gas-engine design.

The fuel injector, which is of the high-pressure force-pump type, is placed near the top of the vaporizer and the spray is directed at a downward angle on to the hot cap.

The shape of the combustion chamber does not permit of high compression pressure, but that adopted, namely, 150 lb. per square inch, is suitable for this type of engine. It represents, however, the lower limit, and in England, where these engines originated, a higher pressure is preferred, varying from 250 lb. per square inch in most cases to 300 lb. per square inch in some instances. The lowest possible compression, however, sufficient to accomplish a given object, is the one generally desired. When this point of view is taken the performance of an engine both at full load and at no load should be carefully considered.

The side-by-side arrangement of the air and exhaust valves necessitates the use of individual cams. As it is not desirable to use an outer bearing on the cam shaft, it follows that some overhang must be allowed for in the valve gear. This overhang is not serious since the exhaust cam is placed close against the governor bracket and the inlet cam has little resistance to overcome.

The fuel injection pump, driven by a cam on the side shaft, is controlled by the governor on the overflow principle by affecting the commencement of the injection period. This system is perfectly satisfactory and frequently adopted. Some critics have advanced the theory that the commencement of the injection period should be kept constant, and the closing period be made variable, as is done in the Diesel engine. They have lost sight of the fact that semi-Diesel engines of the type now under review, operate with combustion at constant volume, and not at constant pressure. In these engines the whole of the fuel must have reached the combustion chamber before or at the dead center, and not later. A small retardation of the commencing phase of injection is quite immaterial, particularly so since a reduced volume of oil requires less time for vaporization than a large volume, and may therefore be injected a little later. The writer has tried out both systems and been unable to detect any difference either way.

Water injection is not used in the Type DH engine, and that fact, in conjunction with the shape of the combustion chamber, should assure a long life of cylinder and piston by preventing an accumulation of either water or carbon deposits on the wearing surfaces.

The economy obtained with this American 4-cycle semi-Diesel engine appears to be equal to the best British specimens of the type. It is in the neighborhood of 0.45 lb. per brake horsepower-hour and remains constant from a point well below ¾ load to about 10 per cent overload. The maximum load is about 20 per cent above the rated horsepower. The compression pressure in this engine amounts to 280 lb. per sq. in., and the pressure of the injection air 600 lb. per sq. in.

Figure 2 depicts an indicator diagram of the "Type DH" and Fig. 3 another taken from the "complete combustion engine" of Messrs. Ruston, Proctor & Co. The similarity of shape is conspicuous except for the compression pressure which, in the case of the latter, was 260 lb. per sq. in.—The Gas Engine.

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Renewing Gaskets

In renewing a blown out gasket on a horizontal steam line, I usually proceed in the following manner. First see that the line is supported on both sides of the flange to prevent sagging when the bolts are removed, then loosen the nuts on all the bolts. Take out all the bolts except 2 below the center, which are left in, but the nuts are taken off or run well back. Sometimes the flanges will spring apart when the bolts are loosened, but not always. Then have 2 thin wedges something like a cold chisel but with longer taper, that are driven between the flanges to spread them apart. When full face gaskets have been used, it is sometimes considerable work to separate them. After the flanges are wedged apart about 1 in., place a nut or block between them at the bottom to hold them apart, then knock the wedges out. The gasket scrapers, of which we have several, are made as shown in Fig. 1. These are kept sharp and with a drop light on the opposite side, the gasket can readily be removed.

In one plant all the gaskets in the large lines that gave trouble were replaced with corrugated copper gaskets in which the corrugations were filled with asbestos wicking. These gaskets fitted inside the bolt holes as shown in Fig. 2, resting on the 2 bolts that are left in place. Where rubber or asbestos gaskets are used, we proceed in the same manner. After getting the gasket in place, the block is knocked out and the bolts put in, the threads are doped with graphite and oil and the nuts drawn up evenly all around working on opposite sides as shown in Fig. 3.

If a ratchet wrench with the proper length of handle, which is the proper thing to use and should be in every power plant, cannot be had, I use a forged wrench made extra heavy with a short handle, Fig. 4, over which a short piece of 1-in. pipe is slipped. The length of this pipe is determined by the size of the bolt and would be about 18 to 24 in. long for a 7/8-in. bolt. The bolts can then all be drawn up evenly without ruining the wrench and without danger of fracturing the bolt or cracking the knuckles.

If a full face gasket is to be used, I proceed in the same manner, but cut the gasket with a ball peen hammer on the face of a spare flange or fitting if one is at hand. If there is none at hand, the bolt holes are laid out with a compass. The 2 holes that correspond to the bolts left in place are cut out as shown in Fig. 5, and ears are left on each side to facilitate getting it into place.

It is essential that the flanges come together square to prevent springing the pipe, and if the job is done properly, it will stay tight. When the pipe is vertical the procedure is the same except that a jack screw, chain hoist or other means must be provided to raise the pipe and separate the flanges. When the pipe is subjected to considerable vibration or is not well supported, a full face gasket should be used to give additional rigidity to the line, also under valve bonnets and in joints where the surface between the pipe and bolt holes is narrow full face gaskets are best. In order to have a satisfactory job, it is necessary to see that the flanges meet fair, that the old gasket has been thoroughly cleaned off and that the bolts are drawn up evenly all around and reasonably tight. When this is done, almost any reliable packing will hold and the job will be successful.

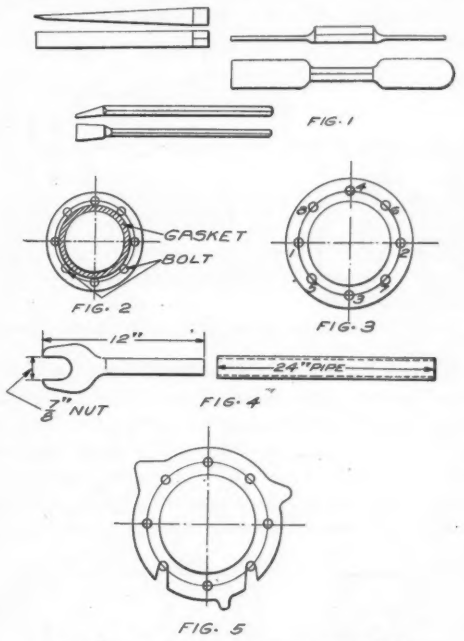


FIG. 1. FORMS OF GASKET SCRAPERS
FIG. 2. LOCATION OF CORRUGATED GASKET
FIG. 3. ORDER IN WHICH NUTS ARE DRAWN UP
FIG. 4. FORGED WRENCH
FIG. 5. SLOTS CUT IN GASKET TO AID INSTALLATION

J. C. Hawkins.

Converting Fahrenheit to Centigrade and Vice Versa

I am entirely in accord with the idea that good results will follow the universal adoption of the Centigrade thermometer as standard. For a time, conversion between the 2 scales will probably be necessary, and it would seem that the rule to convert Fahrenheit to Centigrade —subtract 32 from the Fahrenheit reading, multiply by 5 and divide by 9, the quotient will be the Centigrade

reading—might be simplified as follows: Subtract 32 from the Fahrenheit reading, divide the remainder by 1.8. The reverse operation, to convert Centigrade to Fahrenheit, would be, multiply the Centigrade reading by 1.8 and add 32, the answer being Fahrenheit degrees. A few problems worked by this method instead of the other will show the comparative simplicity.

J. B. DILLON.

Whese Forced Draft Failed

SOME YEARS AGO, I took charge of a laundry plant, which consisted of 1 66-in. by 16-ft. horizontal return tubular boiler with 54 4-in. tubes. There had been installed a new patent forced draft system, consisting of a fan driven by a rotor type of steam engine, all of which set up on the rear end of the boiler setting, the air being driven through 2 10-in. cast-iron pipes through the combustion chamber and then into the ash pit through the bridge wall.

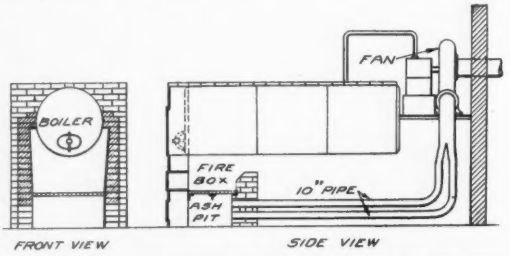


FIG. 1. ARRANGEMENT OF FORCED DRAFT SYSTEM

To operate, it was necessary to keep ash pit doors shut. The idea was to heat the air before it reached the fire. My predecessor found the system was high on coal. He was burning Pocahontas mine run at $4.50 a ton. He found by stopping the fan, opening the ash pit doors and running on natural draft, that he could not only hold steam better, but burn ½ ton of coal a day

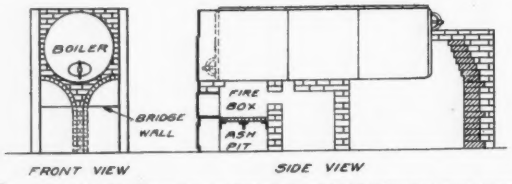


FIG. 2. ARRANGEMENT OF BAFFLE IN COMBUSTION CHAMBER

(of 12-hr.) less, making a saving of $2.25 a day. He disconnected the openings to the 2 10-in. cast-iron pipes and closed the ash pit doors, taking air through the 2 pipes, and found he could hold steam for an hour or so that way.

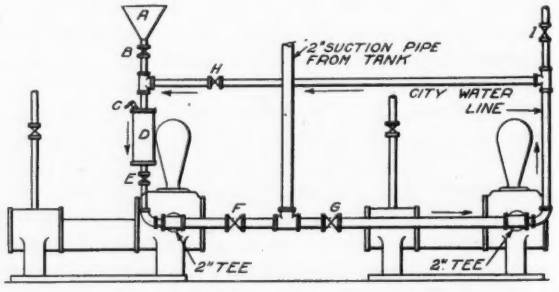
I finally got some help and on a Sunday tore out $7.50 worth of junk in the way of 10-in. pipe, weighing almost a ton. A few years later, the second floor was rented to another laundry, and about twice the load was added to this boiler, increasing the coal consumption to almost twice as much as before, and making it almost impossible to hold steam. The safety valve was set for 125 lb. pressure and we carried 100 to 110 lb. The stack was not high enough, being only 65 ft. To overcome the trouble, 40 ft. of steel stack was added, shaking grates installed and a brick arch baffle was built in the combustion chamber.

This arch had a crack or opening left in it at the girth seam, so that the rivets could be seen and inspected. The part of the arch that drops gets white hot. It is there to prevent smoke, and works fine once the furnace temperatures are up to normal. They now burn No. 5 washed coal, at about $2.50 a ton, and get good results.

A. N. R.

Feeding Boiler Compound

THE ACCOMPANYING sketch shows the piping up of a homemade boiler compound feeder connected up in such a way that compound can be fed through either of the 2 pumps. It is also connected to the city water line, so if anything should happen to the 2-in. suction line from the tank or heater the water could be fed to either pump direct from the city line. Of course, it is not a good policy to feed cold water to a boiler, but this arrangement will prevent having to shut down until you can get the heater started again. It also comes in handy if your water in the boiler is low when you have no steam to start the pumps, or if your hot water tank is



PIPING FOR FEEDING BOILER COMPOUND

below the water level in the boiler. You can turn on the city water and bring the boiler water up to the desired level. Compound can be fed to the boiler through the pumps as follows. To fill feeder, open air cock C and valve B, fill the drum D through funnel A, then close valve B and air cock C.

To feed through pump No. 1, close valve F, open valve G, H and E. Pump No. 1 will suck the water through the feeder through valve G, as shown by the arrows. To feed through pump No. 2, open valves F, E and H, and close valve G; this will bring the water through the pipe in the opposite direction to that shown by the arrows. To feed city water through pump No. 1, close valves F and G, open valves I, H and E. To feed through pump No. 2, have all valves closed except valve I.

JOHN W. FERGUSON.

Trouble with Throttling Governor

J. C. HAWKINS' article in Feb. 15 number calls to mind a little experience I had a few years ago with an engine with a throttling governor. This engine was used to run a small generator for lights. One night I noticed the voltage go up and the engine started to race. The throttle was closed and the belt was looked at, as I thought it might have been slipping, but upon examination it was found not to be the case. I finished the run by regulating with the throttle valve.

After shutting down, the inside of the governor was taken out and the brass lining in the governor, which was a Waters governor, had worked loose and had worked up. The lining was driven back and 2 small bolts were put in to hold it down in place.

On another occasion this same engine slowed down, and upon examination of the governor the stem inside was found to be broken and the inside of the governor had dropped down and partly shut off the steam.

A. A. WILLIAMS.

A Daily Plant Record

IN MY PLANT we are making a daily record which may be of interest to some other engineers for comparison. We have one Corliss engine, 20½ by 48 in., running at 96 r.p.m., from which we have to get at times over 400 i.hp. To supply steam, there are 2 h.r.t. boilers, 84 in. diameter, and to keep track of the boiler performance, we have a Venturi water meter which is read twice a day; all coal is weighed, and regular tests of the CO_2 are taken to get the average value. Feed water enters the boiler at 220 deg. F., passing through a closed heater, on which a back pressure of 10 lb. is carried. The coal has a heat value of 14,470 B.t.u. Herewith is a table of performance for 5 days per week during the month of January, 1916:

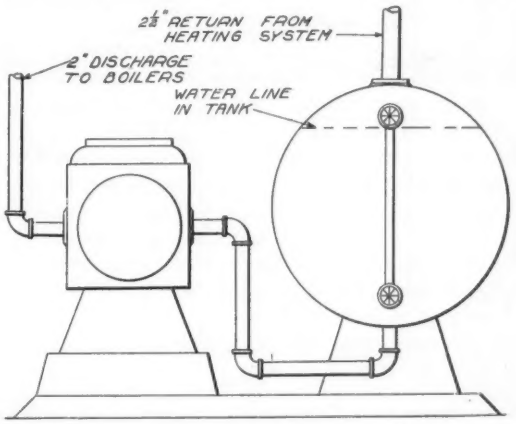
Date	Weight of Water	Weight of Coal.
Jan. 3	143,000	13,000
Jan. 4	144,000	12,210
Jan. 5	144,000	12,010
Jan. 6	145,000	11,690
Jan. 7	140,000	11,375
Jan. 10	135,000	10,735
Jan. 11	126,000	10,565
Jan. 12	149,000	12,415
Jan. 13	126,000	10,420
Jan. 14	118,000	9,110
Jan. 17	121,000	11,930
Jan. 18	117,000	12,220
Jan. 19	130,000	10,675
Jan. 20	136,000	11,130
Jan. 21	107,000	9,350
Jan. 24	100,000	8,805
Jan. 25	110,000	8,250
Jan. 26	110,000	8,980
Jan. 27	113,000	8,550
Jan. 28	101,000	8,230

P. C. V.

Trouble with Vacuum Pump

WHILE FITTING UP the heating system of a school, an incident happened that may be of interest to the readers of Practical Engineer. The system was a patented vacuum job, steam being used from 2 80-hp. boilers at reduced pressure. The returns were carried back to a pump and receiver and from there fed to the boilers.

This is what happened: The engineer shut off steam on the heating line, but left the pump running. In a few minutes the pump started to run away; it was not getting water. The engineer looked at the gage glass on the receiving tank and this showed that the tank was ⅔ full. He tried the pet cock, which seemed to be exhausting all right; so, thinking that something was wrong with the valves, he started to take the pump apart. I happened in about this time and he asked my opinion. After looking over everything, I discovered what was wrong. In shutting off the steam, he had



RELATIVE LOCATION OF PUMP AND RECEIVER

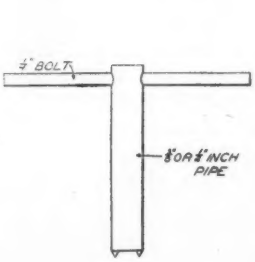
practically closed the system and the steam, condensing, had formed a vacuum that held the water in the receiving tank, not allowing any to pass to the pump cylinder. After breaking this vacuum, the pump worked all right.

EDW. A. DOERR.

Regrinding Valves

VALVES, SUCH AS found on the water ends of reciprocating pumps, may readily be reground by means of the cheap and easily constructed device described in the following paragraph.

Take a convenient length of ⅜ or ½-in. pipe and by means of a hack saw remove enough of one end to leave 2 oppositely placed projections of proper size to fit the slots of the valve disc shown in Fig. 2.



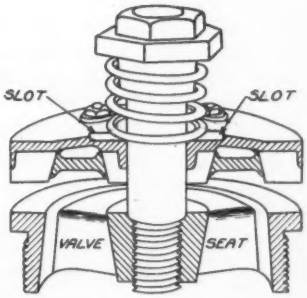


FIG. 1. EASILY CONSTRUCTED VALVE REGRINDING DEVICE
FIG. 2. TYPICAL PUMP VALVE SHOWING SLOTS IN DISC TO ACCOMMODATE PROJECTIONS OF TURNING HANDLE

Remove the disc stud and spring. Replace the former by one about 6 in. long, and of such diameter as to allow the above-mentioned pipe to slip over it. By means of a handle made of a short length of an old ¼-in. bolt and fitted to the pipe as shown in Fig. 1, the disc may readily be turned on its seat and the 2 thus ground to a smooth working surface.

A. GROHMAN.

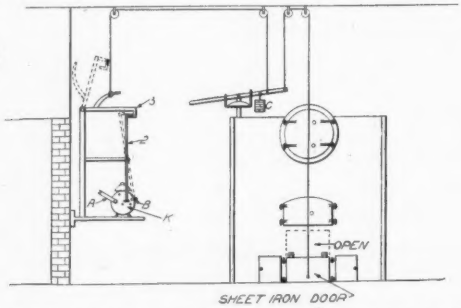
Successful Kinks From The Plant

For Saving Time, Work and Trouble

Device for Starting Draft

WHILE LOOKING through the heating plant of a private institution, my attention was attracted to the arrangement shown in the sketch. The janitor told me that in the winter time he had to leave home at 4 a. m. in order to have the place warm at 6 a. m.; however, since he made this rigging he doesn't have to get out until a later hour.

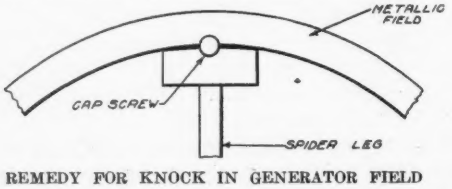
Just before going home at night, he sets the alarm clock K to go off at 4 a. m., and when it does the lever A hits the lower end of lever 2, releasing 3, which assumes the dotted line position, allowing the weight C on low-pressure damper regulator to pull the lever down to its working position, thus making the sheet iron door, over ash pit opening, assume the position of dotted lines and the fire starts to raise the steam. The forked end of A catches on the T end of B when the alarm goes off, and in order to wind the clock all one has to do is push lever A back to the position it now occupies. This arrangement has been in operation since cold weather set in and has never missed yet. J. H. ARMSTRONG.



ARRANGEMENT OF CLOCK, LEVERS AND CHAINS FOR STARTING BANKED FIRE

Remedying Knock in Generator

AT THE PLANT where I am employed is a 40-kw. 60-cycle generator that runs continuously. The armature is stationary and the field is of a rotating type. The circle that the spider describes, on which the field is mounted, is 20 in. in diameter and contains 5 legs. The trouble that developed was a decided knock during every revolution of the field and became more pronounced as the machine remained in service. The knock was difficult to locate.



REMEDY FOR KNOCK IN GENERATOR FIELD

As the generator is direct connected to the engine, the sound could apparently be located in any part of the machine; but finally running it down, I located it where the laminated field is attached to the spider. An electrolysis was in action between the metallic field and spider, which had caused the metal to rust enough to loosen the field where it is mounted on the spider. I tightened the field by inserting one 5/8 by 4-in. cap screw in each spider leg where it joined the metallic field.

The holes were drilled so that one half of the capscrew is in the spider leg and the other in the metallic field. The tendency action on the capscrew between the metallic field and spider legs, while the machine is in action, is a longitudinal shearing.

The machine has been in operation for 6 mo. since the repair was made and has given no trouble since.

Handy Joint; Copper Jacket for Tool Handles

FIGURE 1 is a handy, though simple method of making a joint for showing valve movements and other working parts of machinery where it is desirable to make the parts of paper or other light material. A pin is pushed through the parts and on into a cork, as shown.

Figure 2 is something that will supply the engineer with profitable spare time work. A wooden tool handle is centered in the speed lathe for the screw C. This screw holds an end of soft copper wire, which is wound tightly around the handle, terminating at the tool end. Handle and all is then dipped in soldering fluid, then in molten hard solder. Next, the handle is again chucked in the speed lathe, and a center located in head of screw C. Turning then, in chuck, and on tail-center, the soldered wire is filed with a coarse file until only copper shows, as at side B. This gives a very neat appearing copper handle of some thickness and light weight. It prevents the wooden handle from splitting, and is altogether well worth the time spent in making it.

J. B. MURPHY.

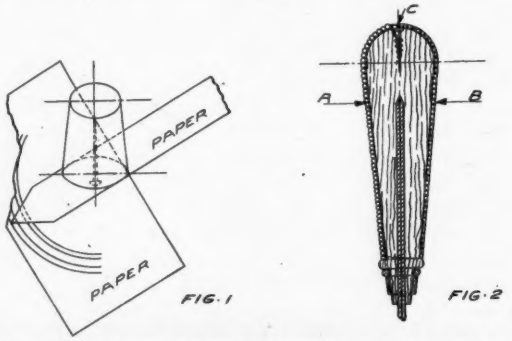
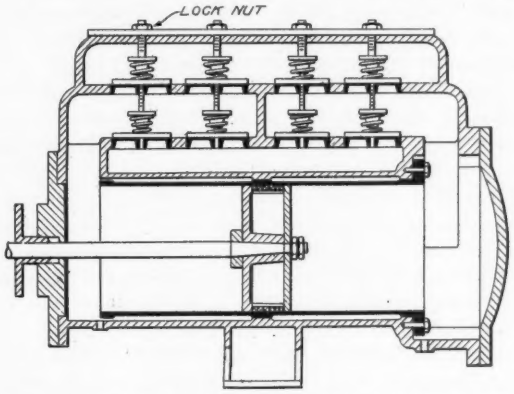


FIG. 1. JOINT TO DEMONSTRATE VALVE MOTION
FIG. 2. COPPER COVERED TOOL HANDLE

Overcoming Pump Difficulties

IN TAKING CHARGE of a plant, I was confronted by a boiler pump trouble that caused me a good deal of worry. The pump was a 14 by 8 by 12-in. piston packed Gardner duplex. The feed water temperature ranged from 75 to 212 deg. F., according to the amount of exhaust through the heater, this difference being caused by the engine's being used but intermittently. As a result of this constant change the pump casting would continually expand and contract and loosened the valve seats, which though screwed in good and hard, would come out just the same. After worrying along with it for some time, I finally hit on an idea which I followed, and have had no trouble with the pump since.

The scheme employed may be readily understood by referring to the diagram. The discharge valve stems were made of such length as to pass through the seats

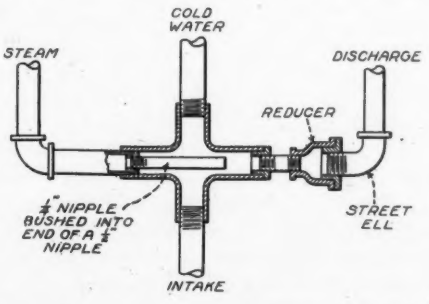


ARRANGEMENT BY MEANS OF WHICH VALVE SEATS WERE HELD IN PLACE

and touch the suction valves; then I bored and tapped holes in the cover plate directly above the discharge valves so that long set screws screwed into these holes would press lightly on the valves below in the same manner as the stems of the discharge valves touched the suction valves. A lock nut with a washer below served to hold the set screws in place. A. L. MITCHELL.

A Homemade Ejector

AN IMPROVISED ejector made from a pipe tee and nipple is, I believe, an old trick among engineers. Recently I had a quantity of hot water to remove from a tunnel, the total lift of this water being about 8 ft. The water had risen until the live steam pipe was submerged thus keeping the temperature of the water very near the boiling point. After having tried the ejector and failed I conceived the idea of using a cross instead of the tee with an additional cooling-water tap. This worked nicely and I am passing it on to those who may never have heard of it



SECTIONAL VIEW OF HOMEMADE EJECTOR

A straight ½-in. cross was used, but the discharge pipe was made ¾-in. by means of a reducer, so a full ¾-in. discharge was obtained.

In starting the ejector, I first turned in the cold water full; then turned on the steam until I got a good full discharge when I slowly turned off the cold water until the discharge broke. After marking position of this valve at breaking point of discharge, I went over the procedure of starting and then closed the cold water valve nearly to the position at which the discharge broke.

J. M. ROW.

A Handy Oil Pump

FOR PICKING up oil drips from pans around engines, I have made a handy pump which is easily made and may be used in many other ways than that mentioned above.

In Fig. 1 is shown the barrel and nozzle. The barrel is a 2-in. brass tube 16 in. long, while the nozzle is a funnel-shaped sheet-copper tube soldered to the barrel. The other end of the barrel is threaded.

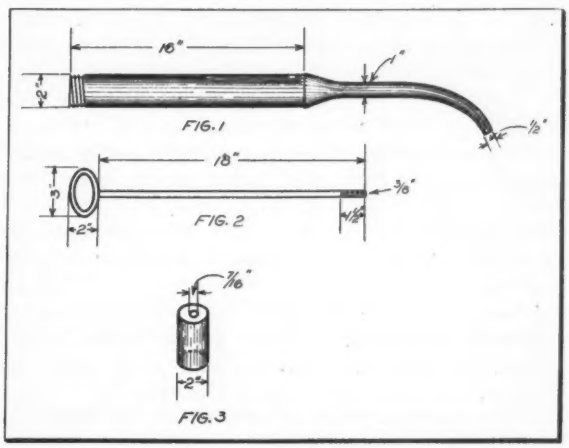


FIG. 1. BARREL OF OIL PUMP
FIG. 2. PISTON ROD OF PUMP
FIG. 3. GREASE CUP COVER SCREWED ON END OF BARREL

In Fig. 2 is shown the form of piston rod used. This is a ⅜-in. round iron rod threaded 1½ in. at one end for 2 lock nuts and 2 washers 1¾ in. in diameter. Between the washers and nuts are held 2 close-fitting gaskets made of sheet packing.

On the threaded end of the brass barrel is screwed the cover of an old grease cup 2 in. in diameter and a hole is drilled in the center for the rod. Figure 3 shows this cover. F. M. JOHNSON.

THROUGH THE Bureau of Foreign and Domestic Commerce, a firm in Portugal has requested to be placed in touch with American manufacturers and exporters of copper, wire and iron suitable for casks, barrel hoops, etc.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Retaining Equal Cutoff

IN REGARD to Corliss motions of the Dobson, the Reynolds and other types, why it is that if set to cut off at say, ⅓ stroke and it accomplishes this result equally at both ends of the cylinder, if the governor changes the position to, say, ½ stroke, the cutoff will not remain equal; and is there any type, such as the drop valve, that will? B. H.

A. The reason why a valve set to cut off equal at a given point, say, at ⅓ stroke, does not cut off equal at points above or below ⅓ stroke, is on account of the angularity of the connecting and eccentric rods, especially the former.

Using for the time being the plain slide valve with which to illustrate, if you care to go to the trouble to perform a little experiment on your own account, you can easily see why this seeming inconsistency is always present. If you use a drawing board, make the sketch as large as possible, drawing accurately to scale. On a straight line scribe a circle which represents the path of the crankpin, and the diameter of which represents the stroke of the engine.

On this line also draw your valve in section and a suggestion of the steam and exhaust ports, located at a distance from the center of the circle equal to the length of the connecting rod. For convenience disregard the piston rod and the valve stem making the connecting and eccentric rods connect direct to the center of the piston and valve, respectively. This brings the parts nearer and assists in getting a clearer understanding.

Then, by using a connecting rod about twice the length of the stroke the seeming discrepancies to which you refer are enlarged so that the reason for their presence is more easily seen.

Divide the diameter of the crankpin circle into thirds, which represent a cutoff of ⅓ stroke. Then with a radius of twice this diameter (the length of your connecting rod), note where the crankpin would be on the circumference, on the out stroke. Now, with the same radius, begin on the other point of cutoff and you will find that where the radius strikes the circumference, it is much farther along than on the out stroke, and is not on the exact opposite side of the circle as one might naturally suppose.

If, in the second instance, however, you start on the circumference opposite the first point of contact, and scribe with the radius toward the diameter, you will be astonished to find that while the crankpin was in the same relative position in its path when cutoff occurred on the return stroke as it was on the out stroke when cutoff took place, the actual point of cutoff was at less than ⅓ stroke.

So, in setting vales, if the "setter" is on to his job, he will learn (if necessary) or determine on a point where cutoff is expected to be equal at both ends. On a majority of engines there is a given point where the load is practically constant, so to speak, and momentary fluctuations are slightly above or below this point.

For instance, a factory engine might have a load that ranged from 200 to 300 hp., but would generally hover around the 250 mark. It would be the wise thing in such a case, to set the valve so as to give equal cutoff at 250 hp. and if the cutoff was unequal at points above or below this, the variation would not be very great; in fact, in everyday practice, it is hardly worth noticing.

On new work the engine builder generally specifies the point of greatest economy of operation which is usually about 21 per cent in most 4-valve engines, so that the erecting engineer has but to set his valves so that they cut off equal at about 21 per cent of the stroke under full load conditions.

With a single valve, in order to secure equal cutoff at any given point of the load, it will be necessary to adjust the valve slightly on the stem till the desired result is obtained, which will distort the other 3 events of the cycle somewhat, and all 4 of them at other points of cutoff.

As a result of many years of study by many designers and builders, valves of the single multiported type have been made with many intricate changes in lap, etc., so that when compared to the time-honored old slide valve which was the basis of all other valves, one would naturally suppose that all proportions were wrong; but when in action and being controlled by a flywheel governor of some kind, also having numerous apparent inconsistencies to the uninitiated, the indicated results come very close to being nearly perfect over wide ranges of load.

B. V. Nordberg has done some wonderful things in valve designing to meet a wide range of exacting conditions, especially in the compressor line, and by swinging the wristplates a certain amount off center instead of equally on both sides of the center, and doing the same things with some of the steam levers, he obtains satisfactory results over wide ranges of loads.

The Walschaert valve gear which is now generally used in railroad practice, is practically perfect in the distribution of steam under all reasonable ranges of load; however, this gear is not particularly adaptable to stationary work except occasionally in double or compound engines for special work of an exacting nature, where it can be used to advantage.

There are engines made with slide yokes for both crank and eccentric, thus eliminating the connecting and eccentric rods and their annoying angularity. They are used mostly in the brewery trade, and similar work

on small compressors, etc. With this device, no change in the design of the valve is necessary from the theoretical, lap and lead being the same and constant at both ends. Large stern- and side-wheel river boats use a modification of this device, and with the unusually long connecting rod generally found in river boats (from 5 to 6 or more times the stroke) excellent results are obtained. G. H. WALLACE.

Regulation of Pop Safety Valves

PLEASE GIVE ME instructions to regulate a pop safety valve. M. J. C.

A. Spring loaded safety valves are adjusted by means of a head bolt and nut at the top of the casing. Some styles of these valves are equipped with a lock-up arrangement which prevents tampering with the valve after it has once been adjusted.

Adjustment is made by screwing up or down the head bolt, according as the compression of the spring needs to be increased or diminished to allow the valve to blow at the required pressure as shown by the steam gage. After the spring is properly adjusted the head bolt should be secured by tightening the lock nut.

The disc of a pop safety valve is surrounded by a ring which forms what is called a huddling chamber, the depth of which determines the amount of blow-back of the valve. This ring is threaded, and by properly adjusting depth of huddling chamber the amount of blow-back can be varied as desired. If the ring is screwed down, the depth of the huddling chamber would be decreased, and the amount of blow-back would be diminished. W. P.

Answers to Ohio Examination Questions

FOLLOWING are the answers to the first 9 of the Ohio Examination Questions which appeared on page 931 of the Oct. 1, 1915, issue:

1. The allowable steam pressure on any steam boiler may be found by the following formula:

$$p = 2\ S\ T\ e \div f\ D$$

Where S = the tensile strength of the boiler sheet;
T = the thickness of the sheet;
e = the efficiency of the joint;
f = the factor of safety;
D = the diameter, in inches.

The value of p, in the case under consideration, would be equal in both instances, that is, p is the same for a 48-in. boiler as for a 60-in. boiler, so that we have:

$$2\ S'\ T'\ e' \div f'\ D' = 2\ S\ T\ e \div f\ D,$$

and the left-hand side of this equation referring to the 48-in. boiler and the right-hand side to the 60-in. boiler.

Now, under the conditions stated in the problem, the thickness of the shell is in both cases the same, and we will assume that the tensile strength, or the value of S' and S, is the same, as also the factor of safety, or f' and f.

Cancelling these like values in the above equation, we have,

$$e' \div D' = e \div D$$

D' is equal to 48 in., and D to 60 in., so that we have,

$$\frac{e'}{48} = \frac{e}{60}$$

From this we see that the condition under which a boiler 60 in. in diameter can withstand the same pressure as a boiler 48 in. in diameter, is that the efficiencies of the joints vary directly as the diameters of the boilers.

2. In vertical fire-tube boilers we have 2 types: the ordinary type, which has the upper ends of the tubes in the steam space, having the hot gases on the inside and steam on the outside, which would absorb the heat, making superheated steam.

The submerged type has all the tubes totally submerged by having the upper tube sheet below the water line, and connecting it with a smoke flue to the upper head. In this way the entire length of the tubes are surrounded by water.

3. The tube as ordinarily understood, is measured by the outside diameter, and the dimensions are somewhat different from that of a pipe. Ordinary pipe is measured by the approximate inside diameter.

4. There is no difference between the angularity of the connecting rod for horizontal and vertical engines, except that in vertical engines the ratio of the length of connecting rod to that of the crank is usually less, so that there is a greater angularity effect.

5. Five advantages of the Corliss engine over the slide valve engine are: (1) The valve ports may be made short and direct; (2) Clearance, volume and area are reduced to a minimum, resulting in a reduction of steam consumption; (3) Valves are made to operate promptly, without loss of power due to wire-drawing; (4) Closing of inlet valve at point of cutoff is effected in such a way as to leave the points of admission, compression and release unchanged, which permits them to occur at the proper points of the stroke; (5) The ordinary slide valve has a heavy pressure bearing upon it, causing excessive wear, not only of the valve, but also of the seat. This pressure is caused by the steam acting directly on the top of the valve—a thing which cannot occur with the Corliss valve.

6. In order to obtain a greater range of cutoff in a Corliss engine, separate steam and exhaust eccentrics are used.

7. Steam pressure is the same in all parts of the boiler, but the total pressure will be greater on the bottom than on the top, due to the weight of the water in the boiler, which will add to the steam pressure, one pound for each 2⅓ ft. depth of water.

8. Fire cracks are small cracks that are found radiating from the rivets most exposed to the fire, and are found most frequently in the girth seam over the combustion chamber. They are generally not over an inch long, but sometimes extend several inches into the sheet. Most of them, however, will be found extending from the rivet to the edge of the sheet.

It is practically impossible to calk rivet cracks effectually, as they are caused by unequal expansion and contraction, assisted by scale settling on the sheets inside of the boiler, and the cause will soon spoil the best job of calking.

If the crack runs into the sheet, drill a hole at the end of the crack and drive in a rivet, or screw in a plug, preferably copper, but be sure that you are at the end of the crack. Use a strong glass to determine where the end of the crack really is.

There is a certain amount of danger connected with the presence of fire cracks, no matter how small in number and size. They should be closely watched. If they defy a few careful treatments, take the first opportunity to cut out the cracked sheet and rivet in a strip.

They are also found in the side walls and crown sheets of locomotive type boilers, and where the staybolts or crown stays are all right, the crack can be stopped effectively till necessary to renew the sheet from general wear, by drilling at the end and screwing in a small copper plug, say, about ½ in. Then, beside this and cutting into it a little, drill another hole and screw in another plug, and so on to the end next the rivet or staybolt where the crack started.

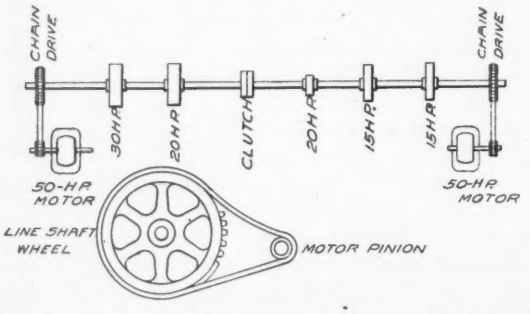
Rivet cracks will usually manifest themselves when the boiler is under service, and one should clean the shell carefully every time one cleans the inside, and look carefully for fire cracks, for like everything else in and about a boiler plant, unless it is attended to at the first opportunity after discovering it, a crack will develop to the point where it is a serious matter.

9. The piston of a steam engine travels the fastest at the center of the stroke. A. L. R.

(To be continued.)

A Transmission Problem

On page 353 of the April 1 issue is a communication from D. S. P. relative to the installation of 2 50-hp. motors to drive a single line shaft, and in order to obtain the proper speed without the use of a countershaft, pulley sizes of 12 and 126 in. will be required. The answer to his question states that either a Lenix drive or an extra flexible belt and plenty of belt dressing should be used. Mr. Near, in the same issue, advises doing away with countershafts which were formerly used to increase the speed ratio for want of a better method. Both writers, however, fail to mention the



GENERAL LAYOUT OF LINE SHAFT DRIVEN BY 2 MOTORS; DETAIL OF CHAIN DRIVE EMPLOYED

highly efficient link chain drive which is coming into more general use every day, replacing belts on short drives and where large pulley ratios are employed.

In the case of D. S. P., the Lenix drive may work very well, but, in my opinion, a silent chain drive would be the proper thing to use. It will be difficult to get the motors to divide the load if both are connected to the same shaft with any type of drive as they will not run exactly at the same speed unless they are synchronous motors. In direct-current motors a slight change of brush position may alter the speed enough to throw the entire load from one machine to the other. The better way would be to use a single motor large enough to drive the entire load, or if the 2 motors are at hand, they may be used and the shaft divided at about the center of the load, having a clutch at this point so that at times of light load or in case of motor trouble the entire shaft can be run at partial load from one motor.

If a chain drive is used the same pulley ratios of 10.5 to 1.0 can be maintained with pulleys of much smaller diameter which would reduce the cost of installation and space required. In this type of drive, if properly arranged with the correct pitch and width of chain the minimum shaft center distance is limited only by the size of the pulleys. That is, the motor may be set so close to the shaft that the pinion barely clears the wheel on the shaft although where space will permit a greater distance is preferable. The chain may be run comparatively loose, preferably with the slack side on top to give a greater arc of contact; although with pulleys of less difference in ratio, this is not important as an arc of contact of say, 120 deg. on the smaller pinion will, if the drive is properly designed, carry all the load that the motor or chain will stand, and without slip.

This drive is practically noiseless in operation and the efficiency is high when the chain is given proper attention. I am at present operating 2 motor-driven air compressors through this type of drive, one 25 hp. and the other 35 hp.; also a 10 hp. motor driving an ammonia compressor. The pulley ratios are 8 to 32, 8 to 28, and 3.5 to 21 in., and the shaft centers are 42, 40 and 40 in. respectively, and although the first cost is higher, I consider these superior to belt drives. We are also using a diamond link chain drive from fan engine to stoker line shaft which runs 24 hr. a day, without giving any trouble. The stokers are driven from the line shaft through a link belt chain 1 in. wide.

In the case in question, if both motors are connected to the same shaft, no matter what type of drive is employed, the operation will not be entirely satisfactory. I should place the motors as close to the shaft as convenient to reduce the cost of chain, keeping in mind the large pulley ratio, bolting the motor to the ceiling or placing it on a platform if necessary to get short centers. Place a clutch at about the center of the shaft load so that with the clutch out the 2 motors can operate their respective ends of the shaft separately. This will give independent operation and make it possible to drive the entire shaft from one motor by throwing in the clutch if the load is not all on. It may not even be advisable to use a clutch depending on the nature of the work, which is not stated. The accompanying sketch shows how I would arrange this drive. The motor may be set on the floor, on a platform or bolted to a side wall or the ceiling as the position of the shaft would determine. Before installing a drive of this form the matter should, however, be taken up with the manufacturers of this type of drive whose advertisements appear in this paper, and who will gladly furnish the required information as to pulley sizes, pitch and width of chain, the best shaft centers and the approximate cost of such drive.

J. C. Hawkins.

Problems For Discussion By Readers

What Would You Do If You Had These Conditions To Meet?

How Can Leakage Be Stopped?

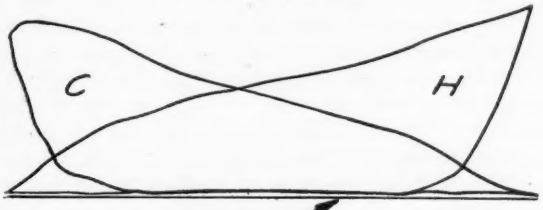
I AM RUNNING a Chicago Pneumatic Air Compressor of the 2-stage cross-compound type.

Unless I keep the rod packing on the front end of the steam cylinder excessively tight, steam continues to blow out between the gland and the stuffing-box on top of the gland, and between the gland and the top of the piston rod. The air and steam cylinders are in such close proximity that there is just sufficient space to insert the packing. The piston rod appears to be in good condition.

Can some reader who has had like or similar trouble tell me how I can remedy it? D. C. H.

Diagram for Criticism

THE ACCOMPANYING card was taken from a 20 by 20 adjustable valve-travel engine, with a piston valve taking steam in the center of the valve and exhausting at the ends. I would like to have the opinion of Practical Engineer readers in regard to this diagram, and what may be done to improve it. INDICATOR.



HOW MAY THIS DIAGRAM BE IMPROVED?

Caring for Injectors

IN REGARD to cleaning injector tubes, an experience of the writer may be of interest. Some time ago, on a large contract job, we were using Mississippi river water for feed in portable boilers, hoists, steam shovels and pile drivers, and had trouble with the injectors clogging up with scale until they would not feed. Most of this formed, of course, on the steam tube of the injector, and when it became excessive we had to shut down the boiler that the injector was feeding, take off the injector and clean it. This shut down, on account of injector trouble, was getting monotonous, and besides, the answering of letters from the home office as to why the units were working only part time was becoming difficult.

Finally, we got a duplicate of each of the 3 sizes of injectors on the different machines, and when one went out of commission, we removed it, put a new one in its place and cleaned scale out of the old one by means of many ingenious shaped scrapers which were made to reach all parts of the interior of the injector.

One night a "walking tourist" came into camp and asked for a "handout" and a job. He got both. He claimed to be an engineer and machinist who had been through the mill from "soup to nuts," so I gave him the injector and some repair jobs. Next day he came over to my shack and said the way we were cleaning injectors "got his goat," and I replied that if he had a better way to "go to it." He asked what boiler compound we were using, and I told him that it was a special brand compound, guaranteed to keep boilers free from scale, rivets, staybolts and stones, and the tourist replied, "Well, that is mostly caustic soda and belladonna extract, so I will take a bucketful of this compound stuff and make a strong solution, which will be mostly lye, then put this scaled injector into it and boil the whole business for about 3 hr. Then I will take the injector out and drop it into cold water, and after it cools, tap it all over with a light hammer, and the scale will come out." Well, I gave him the opportunity that afternoon of trying the experiment, and it worked to perfection. The interior of the injector, after this treatment, was absolutely clean of all scale.

That set me to thinking, and I experimented with prevention as well as cure. I found that, after cleaning the injector, by coating the interior surfaces with a paste made of fine graphite and lard oil, using as little oil as possible, the injector could be kept in service much longer than if not treated. The graphite seems to keep scale from adhering to the surface of the injector for some time, or until it is washed away.

C. E. ANDERSON.

Cleaning Injectors; Blowing Boiler Tubes with Air

FOR CLEANING injectors, we use muriatic acid and take it straight. I cleaned an iron body injector last week by leaving it in acid for about 1 or 1½ hr. It is best to take the injector apart if of iron construction, then leave brass parts to soak until boiling ceases and rinse off. I cleaned a 2-in. check and gate valve in about 10 min. by this method. Acid pure does not injure hands unless cut or scratched. Don't forget to wash off in clean water.

What objections, if any, can readers find to blowing tubes of Stirling boilers with air at a pressure of 100 lb.? No blowing was done until I came here and no hose for steam was available that I would trust; so, having a compressor, I blow them with air. J. C. LEE.

PRACTICAL
ENGINEER
Trade-mark, Reg. U. S. Pat. Off.

PUBLISHED THE FIRST AND FIFTEENTH OF EACH MONTH
BY THE TECHNICAL PUBLISHING CO.
537 South Dearborn Street,
CHICAGO, ILL.

New York Office, 150 Nassau St.

Notify us at once of any change of address, giving the old and the new address, so that your paper may always reach you promptly.

Copyright, 1916, by Technical Publishing Co.
Entered as second class matter May 1, 1908, at the Post Office at Chicago, Illinois, under the act of March 3, 1879.

Circulation of this issue, 22,500.

CONTENTS

Power for Packing Pork. Illustrated....443
Experiences with Corliss Valves. By H. A. Jahnke. Illustrated....446
Efficient Operation of Boiler Rooms. Illustrated....447
Prevention of Corrosion in Pipe. Illustrated....449
Estimating on Piping Costs....450
A Novel Fuel Oil Regulator. By N. W. Duell. Illustrated....450
Oil Leakage. By Gordon Fox. Illustrated....451
Modern Electric Elevators and Elevator Problems. By David Lindquist. Illustrated....453
Small Electric Station Systems....456
Foreign Development in the Power Plant Field. By J. H. Blakey....457
Novel System of Flood Lighting....458
Gas Producer Control—I. By Reginald Trautschold....459
What Is a Semi-Diesel Engine? By C. S. Salfeld. Illustrated....460
Letters Direct from the Plant: Renewing Gaskets. Converting Fahrenheit to Centigrade and Vice Versa. Where Forced Draft Failed. Feeding Boiler Compound. Trouble with Throttling Governor. A Daily Plant Record. Trouble with Vacuum Pump. Regrinding Valves. Illustrated....463
Successful Kinks from the Plant: Device for Starting Draft. Remedy for Knock in Generator. Handy Joint; Copper Jacket for Tool Handles. Overcoming Pump Difficulties. A Homemade Ejector. A Handy Oil Pump. Illustrated....466
Questions Answered and for Answer: Retaining Equal Cutoff. Regulation of Pop Safety Valves. Answers to Ohio Examination Questions. A Transmission Problem. Illustrated....468
Problems for Discussion by Readers: How Can Leakage Be Stopped? Diagram for Criticism. Caring for Injectors. Blowing Boiler Tubes with Air. Illustrated..471
Editorial: Inefficiency by Congressional Decree. Your Opportunity....472
News Notes....473
New Fluid Meter. Illustrated....474
New Ingersoll-Rand Turbo-Blower. Illustrated....475
Dwight CO_2 Indicator. Illustrated....476
Practical Reference Tables; Discharge of Water Through Nozzles. Coal Economy Chart. Fuel Oil Economy Chart. Cost of Power in Isolated Plants Using Exhaust Steam for Heating....477
Books and Catalogs....479
Trade Notes....480

Inefficiency by Congressional Decree

Every wideawake, ambitious engineer is seeking efficiency in his machinery, his plant, himself and his organization. A law to forbid the use of stokers or coal handling machinery would be quickly resented. What sort of a spectacle would Congress make passing an act to prohibit the use of wheelbarrows because a man can handle more coal that way than in buckets? Yet the Tavenner and Van Dyke Bills introduced in the House and now under consideration are of about the same caliber, except that they are aimed against progress in methods of doing work instead of against improved machinery and appliances.

Three factors enter into the cost of every product, whether it be cloth, machinery or energy: These are Labor, Material and General Expense. Of these, usually the labor item is the largest, and, if we are to increase our national wealth continually, which is the only means by which industries can be expanded and new ones started, improved machinery and methods must be found which will permit of increased output per dollar of labor cost. Otherwise, as our standard of living is raised, a larger per cent of the wealth produced will be expended for immediate consumption, leaving a diminishing amount for investment, hence decreasing the opportunity for employment.

One means which has been employed to lessen cost of production per piece produced has been termed "Scientific Management." The principle, properly applied, is not to drive workers or to coax them to excessive activity, but to study existing methods for the purpose of finding where they are inefficient, either because of ineffective tools and equipment, bad management of plant, illogical order of handling work or wasted effort of workers. Then, to make the work as easy as possible by providing the tools best suited, arranged in the best way, with work handled with the smallest waste of effort. Time study is needed to determine what is a reasonable allowance for each operation, performed according to the best method that can be devised and with suitable rest periods to avoid fatigue.

Not hurry, but elimination of wasted motions and delays, is the object, and extra reward is given to those who master the improved methods, and therefore produce greater results.

Suppose that a railroad has been run haphazard, with no provision made for supplying engines or cars when needed and no definite time table in use. Evidently the service would be unsatisfactory and the operation wasteful. By a study of traffic, track, distances and running time, a system is devised so that cars and engines are provided where and when they will be needed, definite train schedules are established, giving fixed times for arrival and departure of trains, with reasonable allowance for running time between stations. The whole business of the railroad will work out to a systematic operation where everybody will know what to depend on and can plan accordingly; much more can be done in transporting goods and passengers, and the cost greatly reduced. The employes will not have to use more effort, but will use their effort intelligently and effectively, and, because of the greater results, the road can afford to pay better wages, yet furnish better service at less cost.

This is the result that Scientific Management seeks to accomplish. Those shops and plants which use it wisely are sure to gain advantages for all in the organization. Legislation which forbids the government to take these advantages simply compels the use of wasteful methods, and purchase from establishments where less efficient methods are in use, so that usually, higher prices must be paid. The people, through taxation, must pay the cost.

If legislation forbidding progressive methods is to become a part of Congressional action it is difficult to see where it will end. Any improvement may be prohibited if there is a sufficiently strong lobby to influence members of Congress to vote that way, and the government may be tied to the most obsolete methods and machinery in all its departments, as well as throwing the weight of its purchasing power against progress in private plants.

If mistaken ideas of progress arise in government or private plants, they will, in a short time disappear by natural evolution; legislation is not needed. And to establish the principle of legislating against the details of attempts at improvement will in the end work harm to the nation at large and to all its industrial interests. It would seem the reasonable thing for engineers, who naturally stand for progress and improvement to throw the weight of their influence against the passage of the bills mentioned, which are an opening wedge for such a legislative policy.

Your Opportunity

It is the narrow outlook that distinguishes a mediocre power plant man from the man who is able and alert. Disraeli, the English author, had no practical knowledge of engineering—probably he could not tell the difference between a B. t. u. and a blowoff valve—but he thoroughly understood the principles of self-advancement when he stated that the secret of a successful life consisted in being ready for the opportunity when it arrives.

Fortunate, indeed, is the modern engineer in having the means at hand for keeping in touch with the activities and accomplishments of power plants which lie outside of his own small sphere. His knowledge is constantly enlarged through contact with the work and thoughts of his fellow workman, as reflected in the writings of men prominent in his profession. Information on new and better methods of doing work, on new and more efficient tools, devices, and processes, and the progress being achieved, is all made public by the efficient power plant journal.

No matter how many years of practical experience he may have behind him, or to what degree of success he may have attained in his work, an engineer can never afford to do without the aid and instruction offered him through the pages of a modern engineering journal. It is absolutely essential to his ultimate success; it is a constant source of stimulation and inspiration.

A capable journal should not be full of "dry as dust" reviews, but have some real live interesting articles. It should serve as a silent partner, an inexpensive teacher, working constantly in the interests of its readers. May we add that to present to the greatest number of readers, news of the widest interest, in an attractive and helpful manner, is the aim of Practical Engineer.

News Notes

In the effort to have the A. S. M. E. Boiler Code adopted as standard in Chicago, the present political situation has proved a hindrance, as Mr. Nye seems opposed to the Code. Chairman Thomas E. Durban of the American Uniform Boiler Law Society has, however, taken the matter up with Messrs. E. W. Lloyd, president of the N. E. L. A., Fred Sargent, J. L. Ford of the Hartford Co., and Louis Mohr of John Mohr & Sons Co., and the matter has been left in the hands of Mr. Mohr with prospect of good results for Chicago and Illinois.

In Louisiana, Professor W. H. P. Creighton of Tulane University, Andrew Lockett and W. O. Hart are working to get a bill ready for presentation to the legislature which meets in May. The Louisiana Engineering Society has in hand a resolution endorsing the Code, and it is expected that the bill adopting the Code for Louisiana will be passed.

In New York, the Boiler Code Bill has passed the House unanimously and it is expected that it will pass the Senate and be signed by the Governor.

Alonzo G. Kinyon, Superintendent of Locomotive Operation on the Seaboard Air Line Railway for a number of years has resigned this position to become Chief Consultant of the Board of Engineering Research Power Generation in Steam Locomotives, for the Powdered Coal Engineering & Equipment Co., Chicago. Mr. Kinyon's knowledge of matters covers a wide period of service, starting 28 yr. ago and it has been one of his ambitions in life to make for the railroad fireman a position of betterment. In his new position he will have full charge of all development work for locomotive operation.

The Brown Hoisting Machinery Co. announces the appointment of its Vice-President, Alexander C. Brown, to the position of General Manager, succeeding Richard B. Sheridan, who has resigned to accept another position.

William H. Capel, Secretary of the New England Westinghouse Co. and the J. Stevens Arms and Tool Co. of Springfield, Mass., died suddenly on Sunday, April 23, just after he had entered his automobile on his way home from church. The cause of his death was a cerebral hemorrhage.

Mr. Capel was born in New York City, March 8, 1867. In April, 1899, he entered the employ of the Westinghouse Electric & Mfg. Co. holding several positions in the executive offices of this company in New York City, and having been for several years past closely associated with Vice-President L. A. Osborne. On June 2, 1915, he was elected secretary of the above mentioned companies.

His geniality, generosity and wide sympathy won for him the esteem of everyone who came in contact with him. Mr. Capel is survived by his wife and daughter.

Platt Iron Works announces the removal on May 1 of its Chicago office to 1242-43 Monadnock Block. The telephone number will be Harrison 867, and John T. Shay will be in charge of the office as district manager.

Kieley & Mueller, Inc., announces removal of office and stock of steam specialties from 442 Wells St. to 223 West Erie St., Chicago, where the company has more up-to-date quarters and greatly increased facilities for taking care of customers.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

New Fluid Meter

TWO requirements are necessary to obtain a measurement of steam flow: first, to obtain a pressure difference that varies in a known and definite manner with the rate of flow; and second, to measure and integrate the rate of flow by means of this pressure difference.

Various types of orifice fluid meters have been developed by the Bailey Meter Co. of Boston, Mass., for

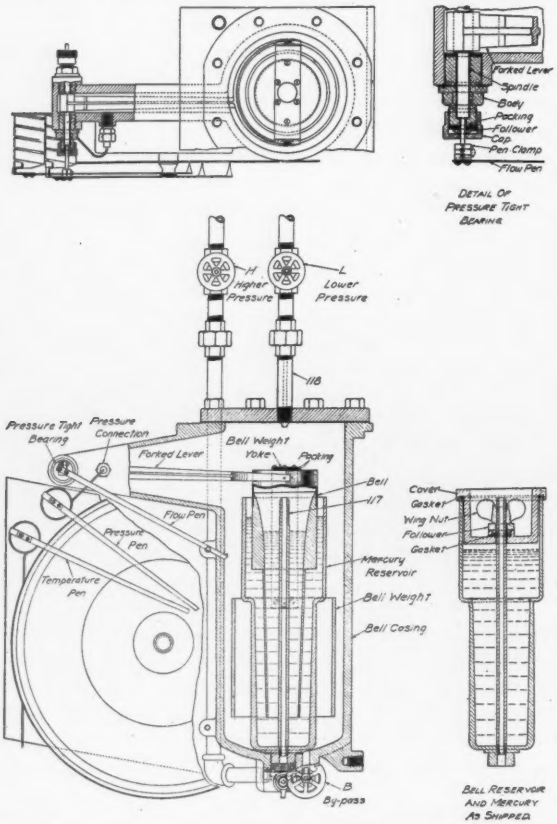


FIG. 1. CONSTRUCTION DETAILS, SHOWING ARRANGEMENT OF OPERATING PARTS

measuring steam, water, air, gas, or other fluid flowing through pipes at any pressure from a vacuum up to 300 lb. per sq. in. They are claimed to be suitable for use with superheated, saturated or exhaust steam in connection with turbines, engines, and heating systems, with feed water, circulating water, hot-well discharge water, and general supply water lines, with air from compressors and to distribution lines, and with natural gas and oil.

Cross-sectional and plan views shown in Fig. 1 illustrate the principal operating parts of the meter and their arrangement.

Type C1 meter, as it is called, is designed primarily to measure and record the rate of steam generation from boilers to show how much steam each boiler is giving. It is also well adapted, it is asserted, for measuring the flow of water, air, gases or other fluids. Records of the pressure and temperature of steam or other fluid may be made on the same chart with the rate of flow, thus giving the complete story of the existing conditions under which the steam or other fluid is being used. This type of meter is illustrated in Fig. 2.

The pressure difference across an orifice plate placed between a pair of flanges in a pipe line is applied to opposite sides of a special shaped bell sealed in mercury, and this acts like a frictionless piston, using the buoyant action of the mercury on the walls of the bell to balance the force due to the pressure difference. The bell has a variable cross-sectional area, so that the recorder gives a reading that varies in direct proportion to the rate of flow. A forked lever engages 2 pins in the yokes connecting the bell-weight with the bell. The other end of the forked lever is connected to the indicator by means of a spindle passing through a pressure-tight bearing.

The special orifice plate used is made of 1/32-in. Monel metal and is corrugated near its outer edge so that it forms its own gasket without any packing. Size of the orifice is proportioned to the size of the pipe, the quantity and density of steam or other fluid flowing through it, so that about ½ lb. pressure drop is secured at average rates of flow. With this small pressure drop no cutting action occurs and the orifice plate is free from corrosion. For high velocity work a segmental orifice plate is used, such as is shown in Fig. 4, so as to secure the correct pressure difference without undue obstruction. In circular orifices of relatively smaller diameter which are used for low capacities, a small drain hole is located in the orifice plate at the bottom of a horizontal steam pipe to prevent any accumulation of water.

When metering steam, it is necessary to have the bell casing and connecting pipes completely filled with water up to an equal and constant level. Each time the bell rises or falls, some water is drawn down in one pipe and an equal volume forced up in the other. To serve as reservoirs and keep the water level, two radiators consisting of horizontal pieces of ½-in. copper pipe with a number of washers or fins are employed.

Another important feature of this meter is the automatic shut-off which prevents blowing out of the mercury or other damage when either of the pressures is excessive, due to an abnormally high rate of flow, improper opening of valve, or even the breaking of one

of the connecting pipes. In case the higher pressure exceeds the lower pressure by an amount corresponding to the maximum rate of flow, the bell will be pushed to its extreme top position and a soft packing held between the top end of the bell and the bell-weight yoke will close the opening in the lower pressure tube, thereby bottling up the water which completely fills the casing

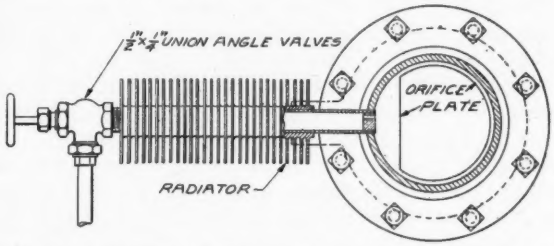


FIG. 4. SEGMENTAL ORIFICE PLATE AND RADIATOR IN HORIZONTAL PIPE

and prevents the forcing of mercury out of the reservoir. In a similar way the higher pressure tube is sealed when the bell is forced down against it by an excessive pressure.

A meter, called Type C2, is designed to measure the pressure difference across an orifice placed between a pair of flanges in a pipe line, and is shown in Fig. 3. An integrator is provided which gives totals directly in pounds of steam, cubic feet of air or gas, etc. The over-all dimensions of these 2 meters are 20½ in. by 17 in. by 6¾ in. All danger of spilling mercury in shipping and installing is obviated by having the mercury hermetically sealed in the reservoir by means of a lid and gaskets held in place by a wing nut.

FIG. 2. METER THAT MEASURES AND RECORDS RATE OF STEAM FLOW

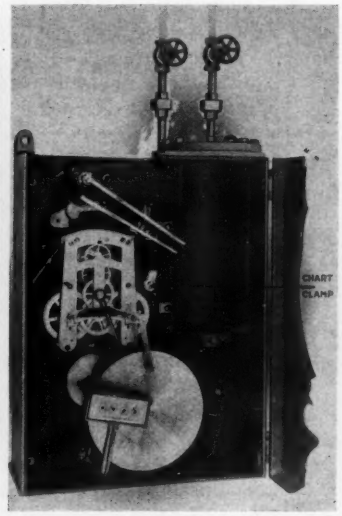


FIG. 3. METER FOR RECORDING AND INTEGRATING FLOW IN PIPE LINE

BUSINESS formerly carried on by the Automatic Vacuum Pump Co., of Chicago, Ill., will hereafter be carried on under the name of the McAlear Mfg. Co., main office and works being at 223 W. Erie St., Chicago.

New Ingersoll-Rand Turbo Blower

THE Ingersoll-Rand Co. has added to its line of turbo compressors and blowers a low-pressure machine to handle volumes from 3000 to 35,000 cu. ft. per minute at from 1 to 2½ lb. These are particularly adapted to such service as foundry cupola blowing, atomizing oil for oil burners, supplying blast to heating and annealing furnaces of various kinds, blowing air for water gas generators, pneumatic conveying and ventilating. They are of the single stage, double flow type and are furnished either electric motor, steam turbine or water wheel driven.

Electric drive is generally employed for the classes of service above mentioned and in the case of the I-R turbo blower, the high operative speed permits direct coupling to motor, a first cost economy.

The motor driven blower maintains constant pressure, while delivering any volume from zero to maximum demand and proportionately varying the electrical horsepower input.

These blowers embody the 4 bearing construction featured in all turbo machines of this make. The casing is horizontally split for ease in installation and subsequent inspection. The assembled casing is doweled and bolted to a heavy sub-base which ordinarily serves for both blower and driving element. This turbo occupies small floor space and its vibrationless operation obviates the necessity for foundation bolting.

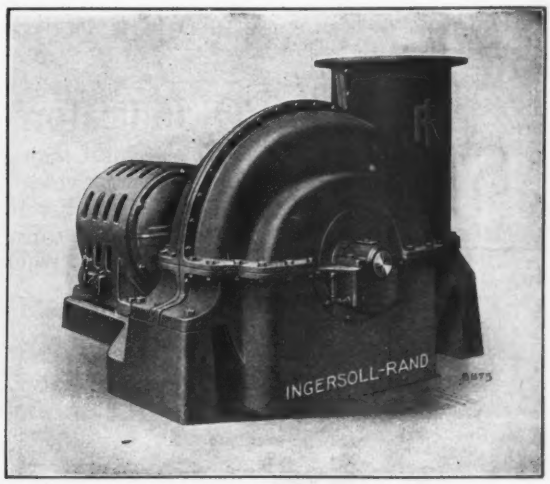


FIG. 1. INGERSOLL-RAND LOW-PRESSURE TURBO BLOWER

The impeller is of the enclosed double flow type, claimed by the manufacturer to secure the highest efficiency. The wheel is machined from a solid, special steel forging. Vanes and covers are of pressed steel securely riveted, all rivet heads being driven flush and the entire assembly polished to reduce skin friction.

Impellers are keyed to a heat treated, forged steel shaft and labyrinth packing is employed to prevent leak-

age between impeller and casing. The use of flexible couplings between blower and driving unit is standard practice on all I-R turbo blowers.

The flow of air from this type of blower is absolutely uniform, avoiding all pulsations, which makes it especially desirable for foundry work. There are no rubbing surfaces in this blower and this precludes the necessity

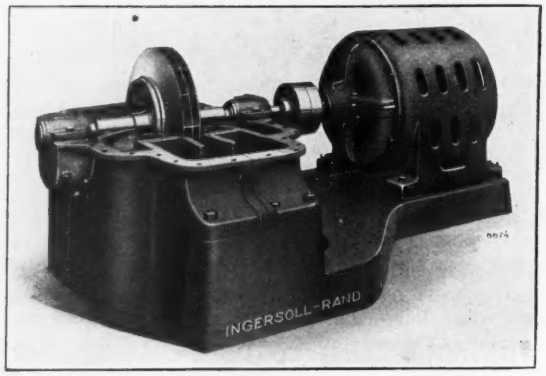


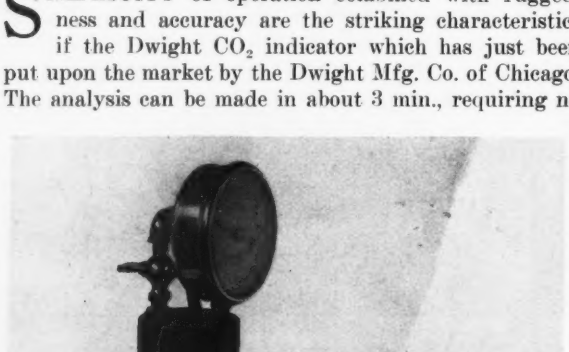
FIG. 2. VIEW OF I.-R. LOW-PRESSURE BLOWER WITH UPPER CASING REMOVED

for adjustment to take up wear and minimizes the cost of maintenance. The I-R turbo blower is said to maintain its efficiency over long periods of time.

It is to be noted that the only lubrication necessary is that of the bearings, all other parts working without friction.

Dwight CO_2 Indicator

SIMPLICITY of operation combined with ruggedness and accuracy are the striking characteristics if the Dwight CO_2 indicator which has just been put upon the market by the Dwight Mfg. Co. of Chicago. The analysis can be made in about 3 min., requiring no



SIMPLE GAS ANALYZER WHICH READS CO_2 DIRECT

fine adjustments, and the instrument gives equal accuracy in the hands of all operators.

Consisting of a cored cylinder with hollow extended base, made of special cast iron not affected by the chemical, the body of the instrument is practically indestructible. To this cylinder is connected a delicate vacuum gage the hand of which swings over a scale calibrated to read the percentage of CO_2 in the gas.

Caustic potash solution with a small percentage of mineral oil is poured into the funnel shown near the bottom of the cylinder to the right, the vent at the top of the instrument being opened to allow the escape of air. About 12 oz. of this solution is used at one charge which is sufficient to fill the base and the lower end of the cylindrical part. The oil immediately separates rising to the top of the liquid sealing the surface of the caustic potash from the gas in the cylinder, thus keeping it unaffected until the instrument is shaken.

By means of a special connection, a hose is connected to the sampling tube and with both cocks open gas is pumped in at the top and out at the bottom of the cylinder thus giving it a thorough scavenging; closing the upper then the lower cock traps the sample to be tested at atmospheric pressure. The instrument is then shaken, which exposes the caustic potash to the gas and the CO_2 is immediately absorbed, creating a vacuum in the chamber which is proportional to the amount of CO_2 in the sample; this vacuum, in terms of per cent CO_2, is indicated upon the dial as the highest point reached by the hand. The oil rises rapidly to the surface of the liquid sealing it from the contents of the cylinder and the instrument is ready for another test.

One charge is sufficient for about 300 tests and to drain the instrument before refilling, a plug is provided in the base at the back.

Annual Meeting of the N. G. E. A.

THE TENTATIVE PROGRAM arranged for the annual meeting of the National Gas Engine Association, at Hotel Sherman, Chicago, Ill., June 27, 28 and 29, 1916, is as follows: Tuesday, June 27, 9:00 a.m., Opening of Headquarters and Registration; 11:00 a.m., Business Meeting; 1:30 p.m., Cost Accounting. Chairman, C. D. Segner in charge. Sales Managers' Get-Together Meeting. Wednesday, June 28, 9:00 a.m., President's Address.

Paper, "Tractor Engines".....W. J. McVicker
Paper, "Tractor Design".....Wm. A. Horthy
Paper, "Tractor Drawbar Ratings"....Raymond Olney
Paper, "Tractor Designing from the Automobile Designer's Viewpoint".....William McGlashan

1:30 P. M.

"The Data Work".....P. S. Rose
Paper, "Ignition Selection".....Harry G. Osburn
Paper, "The Heavy Oil Engine".....
Paper, "Reducing Shop Costs".....Theo. C. Menges
Report of Membership Committee.....O. C. Parker

7:00 p.m., the Annual Dinner. Speakers:

Hon. William N. Hurley, Vice Chairman Federal Trade Commission.

Dr. W. C. Huntington, Commercial Agent, Bureau of Foreign and Domestic Commerce, Washington.

Thursday, June 29, 9:30 a.m., Standardization. Chairman Chas. Kratsch in charge. Report of the Committee.

Report of Pulley Section.....F. J. Lemley, Chairman

These tables contain data especially worked out or carefully selected that are vital to your work. You may read preserve them. A handy, serviceable, loose-leaf cover in

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-leaf cover in which these tables fit exactly, will be sent you for 30 cents in currency or stamps.

PRACTICAL ENGINEER

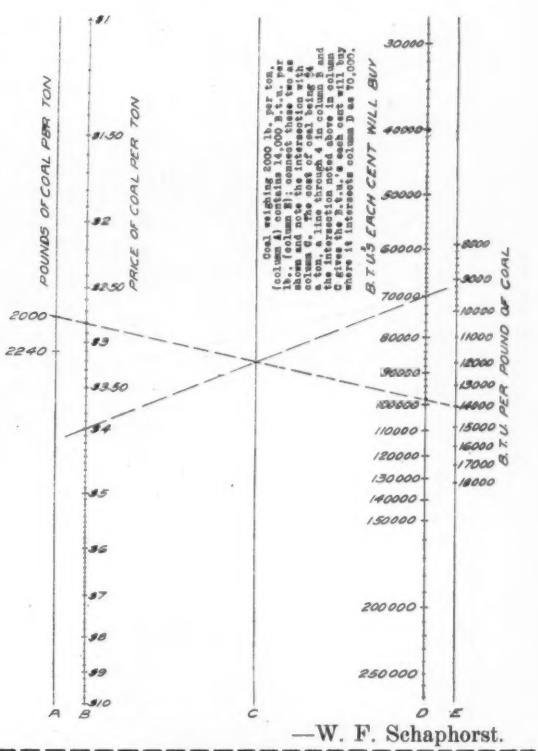
THEORETICAL DISCHARGE OF NOZZLES IN GALLONS PER MINUTE*

Head		Velocity of Discharge in Feet Per Second	Diameter of Nozzle in Inches														
Lbs.	Feet		⅛	¼	⅜	½	⅝	¾	⅞	1	1¼	1½	1¾	2	2½	3	3½
10	23.1	38.58	0.37	1.48	3.30	5.90	13.2	23.6	36.8	53.2	72.2	94.4	119	148	178		
15	34.7	47.25	0.45	1.81	4.02	7.22	16.2	28.7	45.0	65.1	88.4	116	146	181	218		
20	46.2	54.55	0.52	2.09	4.66	8.32	18.7	33.4	52.0	75.3	102	134	169	209	252		
25	57.8	60.99	0.58	2.33	5.23	9.30	20.9	37.2	58.2	84.1	114	149	189	233	282		
30	69.3	66.82	0.64	2.56	5.71	10.2	22.8	40.9	63.7	92.2	125	164	207	256	300		
35	80.9	72.16	0.69	2.76	6.16	11.0	24.7	44.2	68.8	99.6	135	177	223	270	334		
40	92.4	77.14	0.74	2.95	6.60	11.8	26.4	47.2	73.6	106	144	189	239	295	357		
45	104.0	81.83	0.78	3.13	6.99	12.5	28.0	50.2	78.1	113	153	200	253	313	378		
50	115.5	86.26	0.82	3.30	7.37	13.2	29.5	52.8	82.3	119	161	211	267	330	399		
55	127.1	90.43	0.86	3.46	7.73	13.8	30.9	55.4	86.3	125	169	221	280	346	418		
60	138.6	94.49	0.90	3.62	8.08	14.5	32.3	57.8	90.1	130	177	231	293	362	437		
65	150.2	98.35	0.94	3.77	8.40	15.1	33.6	60.2	93.8	136	184	241	305	377	455		
70	161.7	102.06	0.97	3.91	8.73	15.6	34.9	62.5	97.4	141	191	250	316	391	472		
75	173.3	105.65	1.01	4.04	9.03	16.2	36.1	64.6	101	146	198	259	327	404	488		
80	184.8	109.11	1.04	4.18	9.33	16.7	37.8	66.6	104	150	204	267	338	418	504		
85	196.4	112.46	1.07	4.31	9.62	17.2	38.5	68.8	107	155	210	275	348	431	520		
90	207.9	115.72	1.10	4.43	9.89	17.7	39.6	70.8	110	160	217	283	358	443	535		
95	219.5	118.89	1.13	4.55	10.2	18.2	40.7	72.8	113	164	222	291	368	455	550		
100	231.1	121.98	1.16	4.67	10.4	18.7	41.7	74.6	116	169	228	299	378	467	564		
105	242.6	125.00	1.19	4.78	10.7	19.1	42.8	76.5	119	172	234	306	387	478	578		
110	254.2	127.94	1.22	4.90	10.9	19.6	43.8	78.3	122	177	239	313	396	490	591		
115	265.7	130.82	1.25	5.01	11.2	20.0	44.8	80.1	125	181	245	320	405	501	605		
120	277.3	133.63	1.27	5.12	11.4	20.4	45.7	81.8	127	184	250	327	414	512	618		
125	288.8	136.38	1.30	5.22	11.7	20.9	46.7	83.5	130	188	255	334	422	522	630		
130	300.4	139.08	1.33	5.32	11.9	21.3	47.6	85.1	132	192	260	341	431	532	643		

*To reduce to cubic feet multiply gallons by 0.134.

PRACTICAL ENGINEER

COAL ECONOMY CHART



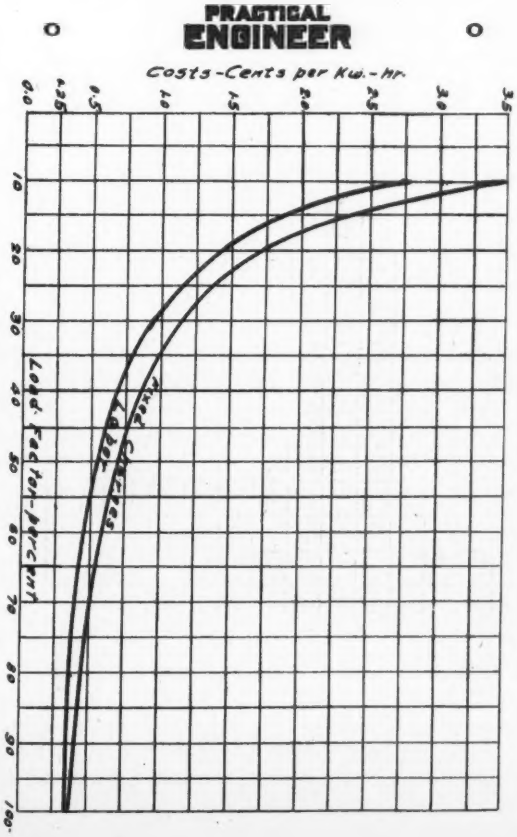
—W. F. Schaphorst.

PRACTICAL ENGINEER

COST OF POWER IN ISOLATED PLANTS

In plotting the accompanying curves, R. S. Hawley of the Colorado School of Mines considers a small plant of 100 kw. average load operating 365 days of 10 hr. each a year; generating equipment, one 100 kw. and one 50 kw. sets; exhaust steam used for heating; steam consumption 60 lb. per kw.-hr. average; steam pressure 100 lb. gage; evaporation 7.4 lb. water per lb. coal; 20 per cent of heat of live steam lost between boiler and heating system; cost of generator sets, $55 per kw. rating; 15 per cent is allowed for interest, depreciation, insurance, etc.; labor and miscellaneous costs $1000 a year. The cost of power given here is the yearly average.

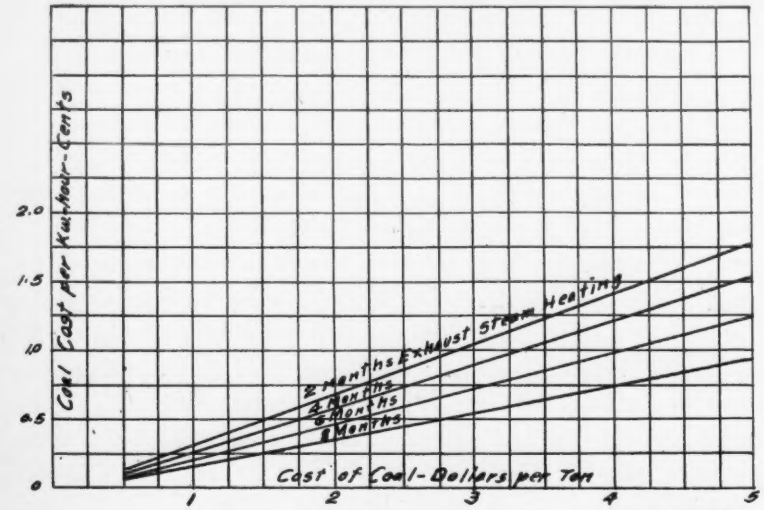
PRACTICAL ENGINEER



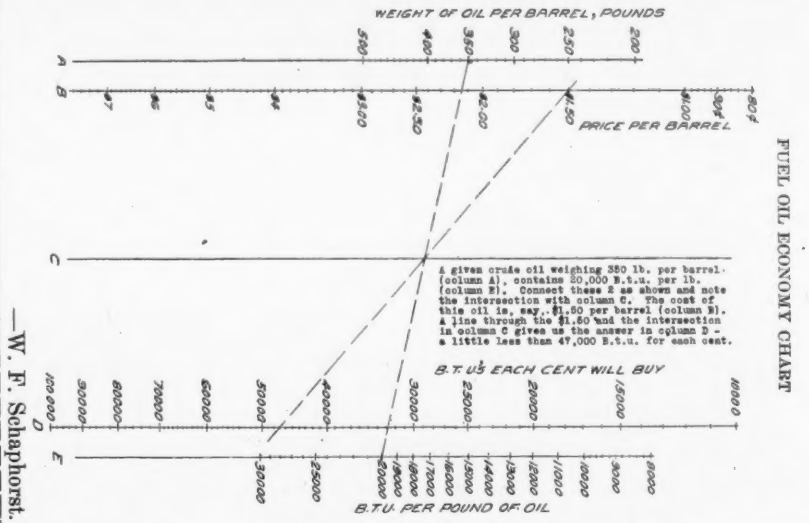
—R. S. Hawley.

COSTS OF LABOR AND FIXED CHARGES

COST OF COAL PER KILOWATT-HOUR IN CENTS.



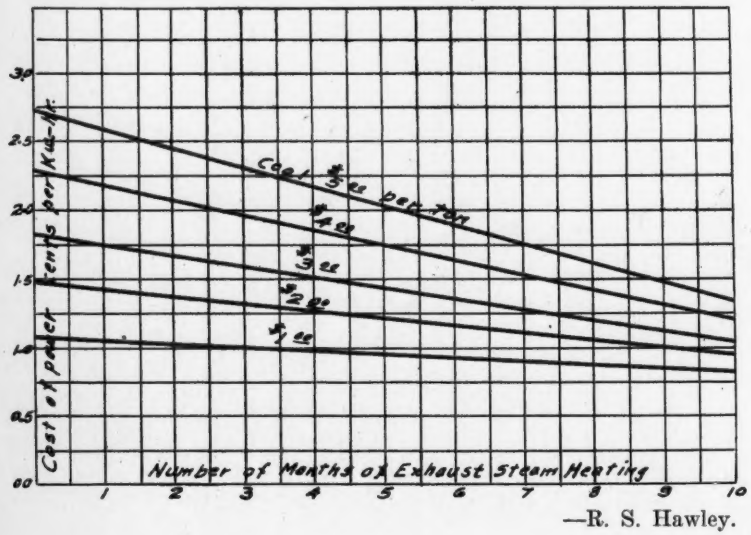
—R. S. Hawley.


WEIGHT OF OIL PER BARREL, POUNDS
500
400
350
300
250
200
A
B
PRICE PER BARREL
$3.50
$2.50
$2.00
$1.50
$1.00
C
A given crude oil weighing 350 lb. per barrel (column A), contains 20,000 B.t.u. per lb. (column E). Connect these 2 as shown and note the intersection with column C. The cost of this oil is, say, $1.50 per barrel (column B). A line through the $1.50 and the intersection in column C gives us the answer in column D - a little less than 47,000 B.t.u. for each cent.
B.T.U.'s EACH CENT WILL BUY
D
E
B.T.U. PER POUND OF OIL

—W. F. Schaphorst.

FUEL OIL ECONOMY CHART

COST FOR POWER WITH VARYING LENGTH OF HEATING SEASON



—R. S. Hawley.

THEORETICAL DISCHARGE OF NOZZLES IN GALLONS PER MINUTE*

Head		Velocity of Discharge in Feet Per Second	Diameter of Nozzle in Inches												
Lbs.	Feet		1½	1¾	2	2¼	2½	2¾	3	3½	4	4½	5	5½	6
10	23.1	38.58	212	289	378	478	590	715	850	1160	1512	1912	2360	2860	3400
15	34.7	47.25	260	354	463	586	723	880	1040	1420	1852	2344	2800	3520	4160
20	46.2	54.55	300	409	534	676	835	1018	1200	1640	2136	2700	3340	4072	4800
25	57.8	60.99	336	457	597	756	933	1138	1350	1828	2390	3024	3730	4582	5400
30	69.3	66.82	368	501	654	828	1022	1240	1480	2000	2616	3312	4088	4960	5920
35	80.9	72.16	397	541	707	895	1104	1340	1590	2160	2828	3580	4416	5360	6360
40	92.4	77.14	425	578	755	956	1180	1430	1700	2320	3020	3824	4720	5720	6800
45	104	81.83	450	613	801	1014	1252	1520	1800	2450	3200	4056	5000	6080	7200
50	115.5	86.26	475	646	845	1069	1320	1600	1900	2580	3380	4276	5280	6400	7600
55	127.1	90.46	498	678	886	1122	1385	1680	2000	2720	3544	4488	5540	6720	8000
60	138.6	94.49	520	708	925	1171	1446	1755	2080	2840	3700	4684	5784	7020	8320
65	150.2	98.35	542	737	963	1219	1506	1830	2165	2950	3850	4876	6024	7320	8660
70	161.7	102.06	562	765	999	1265	1561	1895	2250	3060	4000	5060	6244	7580	9000
75	173.3	105.65	582	792	1034	1309	1616	1960	2330	3170	4136	5236	6464	7840	9320
80	184.8	109.11	601	818	1068	1352	1669	2030	2404	3280	4272	5400	6676	8120	9616
85	196.4	112.46	620	843	1101	1394	1720	2080	2480	3380	4400	5576	6880	8320	9920
90	207.9	115.72	637	867	1133	1434	1770	2150	2540	3470	4532	5736	7080	8600	10160
95	219.5	118.89	655	891	1164	1474	1820	2200	2620	3560	4656	5896	7280	8800	10480
100	231.1	121.98	672	914	1194	1512	1866	2260	2700	3650	4776	6048	7464	9040	10800
105	242.6	125.00	688	937	1224	1549	1912	2320	2760	3750	4896	6200	7648	9280	11040
110	254.2	127.94	705	959	1253	1586	1957	2380	2820	3840	5012	6344	7828	9520	11280
115	265.7	130.82	720	980	1281	1621	2002	2430	2880	3920	5124	6484	8008	9720	11520
120	277.3	133.63	736	1001	1308	1656	2044	2480	2950	4004	5232	6624	8176	9920	11800
125	288.8	136.38	751	1022	1335	1691	2086	2540	3000	4100	5340	6764	8344	10160	12000
130	300.4	139.08	766	1042	1362	1724	2128	2580	3070	4160	5448	6896	8512	10320	12280

*To reduce to cubic feet multiply gallons by 0.134.

Report of Committee on Belt Speeds.....
.....S. M. Walker, Chairman
Report of Committee on Nomenclature.....
.....T. A. Tanner, Chairman
Report of Tractor Section...Geo. A. Schwer, Chairman
Report of Marine Division..W. C. Anderson, Chairman
12:00 Noon.
Meeting of Executive Committee and Election of Officers.
1:30 P. M.
Announcement of Executive Committee Meeting.
Report of Publicity Committee.....
.....Albert Stritmatter, Chairman
Paper, "The Fuel Situation".....E. E. Grant
Paper, "Carburetion".....E. E. Dean
Paper, "Liquid Fuels, Present and Future".....
.....E. W. Roberts
Report of Insurance Committee.....
.....S. M. Walker, Chairman
Report of Special Committees. Unfinished Business.

Books and Catalogs

ELECTRICAL BLUE BOOK FOR 1915-16. This standard book, published by the Electrical Review Publishing Co., at Chicago, Ill., is a buyer's guide of electrical material, and gives in detail the construction material approved by the Underwriters' Laboratories, showing how special devices are to be used, and giving, also, illustrations and trade descriptions of the different standard fittings and apparatus.

The material is divided into classifications and has an excellent index, both alphabetical and classified, which makes references to all parts of the book easy and rapid. On page 193 is given the National Electrical Code, fully indexed, with illustrations and explanations, making the provisions entirely clear and understandable, and showing exactly how installation and construction work must be done in order to conform to the requirements of the Code.

ELECTRICAL POCKET BOOK FOR 1916, issued by Mechanical World, of London, England; 300 pages, 130 diagrams and illustrations. Price, 30 cents.

Description of switchboards with some concise information, is a new feature of the 1916 edition. New sections have been given to earthing or ground connections and efficiency of D. C. dynamos and motors. Accumulator notes have been extended to include information regarding alkali accumulators and Edison cells. The section on lighting circuits and switching has been revised and the subjects of electric lamps and electric lighting have been brought up to date.

Tables such as the average engineer might require are furnished, and space provided for daily memoranda. A complete index makes this pocket book convenient for reference. The book may be obtained from The Norman, Remington Co., Baltimore, Md.

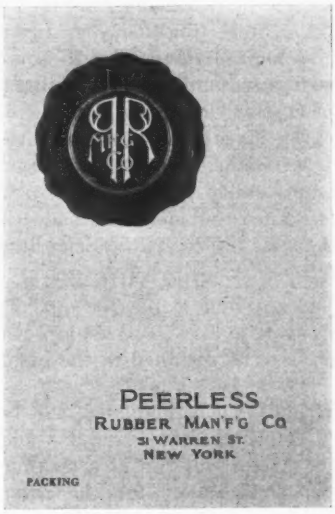
AN ATTRACTIVELY ILLUSTRATED art circular has just been issued jointly by the Pelton Water Wheel Co., of San Francisco-New York, and the Westinghouse Electric & Manufacturing Co., of East Pittsburgh, Pa., describing the Pelton-Westinghouse water wheel generator sets and their applications.

The front page shows an illustration of a mountain stream being put to use driving one of these sets furnishing current for rural districts. The interior pages are devoted to some applications in the home and farm, while the rear page gives some specific information required for the analysis of a proposed water power company. Distribution of this publication is being made by the Pelton and Westinghouse companies throughout the rural districts, and will be sent on request to any one interested.

MODIFICATIONS OF the Standard Type CS Motor, as manufactured by the Westinghouse Electric & Mfg. Co., are described and thoroughly illustrated in catalog section IP45 just issued by this company.

These modifications involve motors adapted for conduit wiring, idler pulley, back gearing and other changes from standard, all of which are treated in this publication.

PEERLESS RUBBER MFG. CO., of New York, has recently issued two booklets which should be of interest to those having packing or belting problems. One booklet entitled "Packing," describes the various forms of sheet packing, gaskets, coil, spiral and ring packing, and combination packing, as applied to meet the various service conditions of power plants. Design of packing for special requirements is given noteworthy attention. This



booklet is well illustrated and divided into three sections, each of which is indexed. "Belting and Its Applications," covers in terse style the requirements of belting for power transmission, conveying and elevating. Illustrations showing actual service installations with various sizes and types, make clear the subjects described. Helpful data and rules for the determination of belt sizes and capacity are also included.

THE LUNKENHEIMER CO., of Cincinnati, has recently issued a catalog entitled Lunkenheimer Motor Accessories, which describes the devices and fittings of its manufacture, for use on gas, gasoline and oil engines.

DESCRIPTIONS OF the Venturi gas and air meter for station and industrial service are contained in a 52-page bulletin, No. 86, which has just been issued by the Builders Iron Foundry of Providence, R. I. The bulletin is divided into two parts: part one is devoted to the

discussion of measurement of artificial gas; part two takes up the discussion of the measurement of high-pressure gas, including natural gas. Brief descriptions of the history, invention and principle of operation of the Venturi gas meter, methods of installing and points of advantage, are given. Illustrations of actual installations are shown and the various types of instruments used are described. A list of standard Venturi Meter Tubes and measuring capacities is also included.

MOVING MATERIAL Indian File is the title of a bulletin just issued by Link-Belt Co., 39th Street and Stewart Avenue, copies of which the company will send to those writing for Booklet 267.

Trade Notes

THE MAGNOLIA METAL CO. have erected an extensive plant in New Jersey for the smelting of antimony, which is used for their own purposes and they are now offering their surplus stock under the name of "MAG" brand. This antimony is said to conform in every respect to the highest standard that can be produced, running 99 per cent pure and better.

AWARD has been made in the suit of F. A. Seiberling, president of the Goodyear Tire & Rubber Co., against the Firestone Tire & Rubber Co. for infrongement of patents of the Seiberling-Goodyear tire-making machine. Most tire manufacturers have for some years been using machines licensed under the Seiberling patents, and this decision confirms the validity of these patents as being for pioneer invention, therefore basic. Machine stretching of the fabric in making vasings insures firmness and uniformity giving greater resiliency and longer life. In future all machine made tires must be manufactured under license of the Seiberling patents.

WESTINGHOUSE ELECTRIC & Mfg. Co., of East Pittsburgh, Pa., has sold to the National Tube Co. the electrical equipment to drive a new 40-in. reversing rolling mill which is to be installed in the plant at Lorain, Ohio.

This rolling mill, when completed, will be one of the largest in the country. The reversing motor will develop 15,000 h. p. and will run at a maximum speed of about 120 r. p. m. Power for the reversing motor will be supplied by a flywheel motor-generator set which will be so controlled that the load on the power plant will be limited to approximately 3000 kw. One of the novel features of this equipment is the arrangement made to allow the reversing motor to be turned over slowly for setting up the mill without running the flywheel motor-generator set.

Sale of a similar equipment has been made to the Indiana Steel Co. which has purchased from the Westinghouse Electric & Mfg. Co. the electrical equipment to drive and control a new 40-in. reversing blooming mill to be installed in the plant at Gary, Ind. The capacity of the reversing motor will be 15,000 h. p. and it will be supplied with power by a flywheel motor-generator set.

In addition to these 2 units the Westinghouse Co. is at present building the electrical equipment for 4 other reversing mills, 2 of which are approximately the same size as those mentioned above.

PRACTICAL ENGINEER

Trade-mark, Reg. U. S. Pat. Off.

PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH.

SEMI-MONTHLY

Subscription price in advance in the United States, Mexico or united possessions, $1.00 a year.

In Canada, subscription price, $1.75 a year.

Foreign Countries, subscription price, $2.50 a year.

Address all letters and make all checks and money orders payable to Technical Publishing Co., 537 So. Dearborn St., Chicago, Ill.

Any advertiser is invited to examine our paid subscription lists and Post Office mailing receipts at any time.

ADVERTISING RATES

Display

Full page, one year, each insertion, $60.00.

Half page, one year, each insertion, $35.00.

Quarter page, one year each insertion, $20.00.

Eighth page, one year, each insertion, $12.00.

Front cover $150.00 per issue.

Other specified positions, regular rate plus 10 to 50 per cent.

Stippled plates used, but no heavy, black and white plates.

Advertisements in this section are inserted under regular headings.

Classified Rates

Per line, 30 cents each insertion.

No display type allowed, but the first three words may be set in capital letters.

About nine words make a line. Minimum space sold, two lines.

Under classification "Position Wanted," advertisements not exceeding four lines will be inserted once for subscribers free of charge.

All copy should be received at Chicago office 18 days before date of publication.

Circulation of this issue, 22,500.

Technical Publishing Co.

537 S. Dearborn Street

Chicago

Position Wanted

POSITION WANTED—By man who has made steam engineering a life study; have had several years 'experience; at present am student in Complete Steam Engineering course with I. C. S. Would like position as engineer, assistant or oiler, with reasonable salary to start, and where I can advance according to merits. Age 26. Address Practical Engineer, Box 419, Chicago, Ill. 4-15-2

POSITION WANTED—As chief engineer or manager of produce cold storage plant. Am familiar with gas, oil and steam engine driven plants, also with D.C. light and power of 250 volts. Erecting, repairing and operating. Employed, married and sober. Will go anywhere. Address Box 428, Practical Engineer, Chicago, Ill. 4-15-3

POSITION WANTED—As master mechanic or assistant; 21 years' experience. Had charge of erecting, repairing heavy duty engines, machinery and mixed blow turbines. Expert on lubricants. Address Practical Engineer, Box 435, Chicago, Ill. 5-15-1

POSITION WANTED—Chief engineer in a small plant or operator in a large; 12 years' practical experience with steam, electric, refrigerating, pumping and condensing equipment. Technical education. First-class license and references; married, age 31, employed. Practical Engineer, Box 434, Chicago, Ill. 5-15-1

POSITION WANTED—License chief engineer wants change; 12 years' experience in manufacturing and central stations, steam electrical, refrigeration and producer gas, high speed and Corliss engines, condensers, etc. Age 32, American and married. Address Box 437, Practical Engineer, Chicago, Ill. 4-1-4

POSITION WANTED—By chief engineer, 35, married. Use no liquor; 15 years' experience, electrical and refrigeration. Wants position where ability and push will count. Can get results if given opportunity. Practical Engineer, Box 436, Chicago, Ill. 3-15-4

POSITION WANTED—Young man wants position as helper, extra engineer or fireman. Two years' practical experience. I. C. S. student. Write Rasmus Stenner, 300 Fremont St., Portland, Ore. 5-15-1

POSITION WANTED—Young man wants position as helper and extra engineer in steam plant for a start. Other particulars answered by leteers. Write to W. D. Bellesfield, Rock Valley, Iowa. 5-15-1

WANTED—Position as engineer in pumping station or in some stationary plant. I have had 4 years' experience in engineering. What have you to offer? E. W. Adkins, Charleston, Ill. 4-15-3

POSITION WANTED—Inside of power plant by young man with a technical education, but no experience. For particulars write to K. Lufter, Kewaunee, Wis. 5-15-1

POSITION WANTED—By young man as oiler or fireman in a modern plant. I. C. S. graduate. Address Frank Knapp, 323 S. 5th St., St. Joseph, Mo. 5-15-1

Help Wanted

WANTED—Resident subscription agents in the following cities: Altanta, Ga.; Cincinnati and Columbus, Ohio; Kansas City, Mo.; Los Angeles, Cal.; Louisville, Ky.; Newark, N. J.; New Orleans, La.; Portland, Ore.; St. Louis, Mo.; San Francisco, Cal.; Washington, D. C. This is an excellent chance for a hustler who is familiar with power plant conditions, to turn his spare time into dollars. To such a one we offer a Real Opportunity. Write Subscription Department, Practical Engineer, 537 S. Dearborn St., Chicago tf.

HELP WANTED—Unassembled examinations will be held for Stationary Engineer, $75 to $100 a month; and Fireman, 160 to 175 a month, for positions in the Illinois State institutions ad department. Examination consists of verification of training and experience and a personal interview. Applications must be filed before June 9. For details and application blanks address State Civil Service Commission at Springfield, Ill., or 904, 130 N. 5th Ave., Chicago. 5-15-1

Wanted

WANTED—Agents handling engine and boiler-room specialties in every section for side line paying large commissions. Give experience, line carried and territory covered. Address Practical Engineer, Box 381, Chicago, Ill. tf.

WANTED—Well versed boiler room and combustion men or established engineering agencies to sell mechanical stokers on a liberal commission basis. We manufacture three distinct types to meet all requirement. Natural and forced draft. Address Practical Engineer, Box 438, Chicago, Ill. 4-1-4

WANTED—Agents on commission to sell our Shaking Grates. We will install grates on trial or put it on test at our expense with any grate made. Address Armstrong Mfg. Company, Springfield, Ohio. tf.

For Sale

ENGINE FOR SALE—One 15x27-in. L.H. Buckeye Automatic Valve Engine, Tangue Bed. Speed, 150-r.p.m. 9-ft. x 25-in. belt wheel. Rated at 150 to 200-hp. This engine used in our factory now displaced by motors. In splendid condition and will sell at bargain price. Nordyke & Marmon Company, Indianapolis, Ind. 5-15-1

BOILERS—Watertube boiler, all insured for 150-lb. steam pressure; 200-hp. Heine, $800; 4 250-hp. Babcock & Wilcox, $1000 each; 6 300-hp. Sterling, $1200 each; 4 300-hp. Heine (like new), $5000. Pumps: 2 Laidlaw and Gordon Fire Underwriter Pumps, 18x10x12, $750 each. Power Machinery Exchange, Inc., 14-16 Morris St., Jersey City, N. J. 5-15-1

FOR SALE—Two 1040-hp. horizontal, cross-compound heavy duty, mill type, Buckeye engines, 24x42x36, 120 r.p.m.; each direct connected to 500-kw., 250-v. Westinghouse Type "Q" generators. Excellent condition; good as new. Now in operation. If interested, write for full information and prices. Box 197, Elyria, Ohio. 4-15-4

Patents and Patent Attorneys

PATENTS THAT PROTECT AND PAY—Advice and books free. High references. Best results. Promptness assured. Send sketch or model for search. WATSON E. COLEMAN, Patent Lawyer, 624 F. St., N. W., Washington, D. C. tf.

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F. St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had, and the exact costs. Send for full information. tf.

A. P. CONNOR, Consulting Electrical and Mechanical Engineer, Attorney-at-Law and Solicitor of Patents and Trade-Marks. Results guaranteed. 121 Carroll St., S. E., Washington, D. C. tf.-x.

PATENTS—Send sketch for free search and reports. Books on patents and book of reference letters sent free. John S. Duffie & Co., 612 F. St., Washington, D. C. tf.

PATENTABLE IDEAS WANTED—Send for three free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf.

Miscellaneous

FREE ENGINEER BOOKS and power plant tools and specialties, for securing new subscribers to Practical Engineer. A dandy chance for the engineer with a little spare time to get some fine premiums. Send for free descriptive circular and terms. Address Practical Engineer, Subscription Department, Chicago, Ill.

ENGINEERS, DO YOU WANT to utilize your exhaust steam for heating or drying purposes without back pressure on your engine? If so, address Monash Engineering Co., 1413 W. Jackson Blvd., Chicago, Ill.

Sparks From The Advertising Pages

SOME BY-PRODUCTS OF ADVERTISING

Advertising was adopted to increase the sale of goods by the particular selling unit doing the advertising, says Mr. Harry Tipper, Advertising Manager of the Texas Co., in Associated Advertising, but it has had effects of a correlated character which are far-reaching in their influence upon business and its connection with the public which bid fair to exert influences greater by many measures than the influence upon the particular organization from a sales standpoint.

These effects have been noticed in many lines of business. The effect of advertising in stimulating the work of a sales organization is so well known to advertising and aggressive sales executives that it has come to be a part of their consideration. The confidence, pride and loyalty which are established in the minds of the salesmen by the public announcement of the value of the product, the policy of the organization and its standard, are by-products of the advertising work not likely to be disregarded.

But this very public character of advertising, because of its prime necessity of interesting the public, stimulates progress not only in the selling organization but in the whole manufacturing development. Anything which will add to the confidence, value or attractiveness of the product can be used effectively in seizing public interest to the advantage of the organization, and the obvious necessity for the consideration of these matters which is forced upon the organization by the conditions of the advertising themselves increases the importance of these matters until they become a part of the daily creative development of the business unit from the beginning to the end of its work.

Advertising, in fact, by committing the business unit to a public policy, publicly recorded, makes it necessary to live up to and surpass that commitment in order that its public announcements shall be more than fulfilled by the service which it renders.

It will require only a moment's thought of the business developments of the last fifteen or twenty years to appreciate the change which has been made in many lines of industry in this regard by the use of advertising.

Not less important has been the effect of advertising upon the distribution facilities of the manufacturer. Before the manufacturer attempted to control his market in a stable way by advertising to the user of his products, he was dependent for his distributing facilities upon the temporary requirements of those who were re-selling to the user, and the whole possibility of his sale in any one area might be wiped out by a temporary disagreement upon price or any other matter with the distributors of his goods.

Advertising, by stimulating a public opinion and by its necessity for identifying the goods to the public, has made it possible for the manufacturer to increase and stabilize the distributing facilities for his particular use so that he may estimate more correctly upon his future business, govern his manufacture and sale more advantageously and work out the sales problems more effectively.

Nor can it be said that there is no valuable by-product in the advertising and selling work of today which permits the men or women in the frontier settlement, 100 miles away from the railroad, to receive and use all the conveniences, styles, clothing, and the ideas of the largest centers of commerce.

Habit of mind, social habit and community ideals change as much with changing convenience as with any other environment, and the close communication between the large centers and the smallest hamlet today is due almost entirely to advertising, which becomes one of the features in their social readjustment.

Finally, advertising is the cards-on-the-table method of doing business. It is the appeal to the public which has been the favorite method of development in politics and religion for centuries. Business morals have been disregarded up until lately. It was not supposed to have any morals, scruples, or responsibilities. It was on the defensive in every court of public opinion everywhere, and because it was secretive, the charges in those courts must be admitted.

But business advertising makes its appeal to the public in a public way. It presents the public with an ideal of service; its claims have their consideration. It lays its claims before the public and asks the public to judge those claims in the light of its own service, by which it admits that it is a servant of the public and that it must rest finally upon the judgment of the public.

Perhaps this, in the final analysis, will be estimated as the most far-reaching of all the by-products of advertising which could be mentioned.